CONTRIBUTIONS TO THE STUDY OF THE KERALA SCHOOL OF HINDU ASTRONOMY AND MATHEMATICS

A THESIS

SUBMITTED TO THE PANJAB UNIVERSITY

FOR THE DEGREE OF

DOCTOR OF LITERATURE

IN SANSKRIT IN THE FACULTY OF LANGUAGES

1977

IN TWO VOLUMES

VOLUME I

BY

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VOLUME ONE

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PREFACE

The Contributions to the Study of the Kerala School of Hindu Astronomy and Mathematics, presented in the following pages form the result of a systematically planned pursuit of the subject for the last several years. This study grew out of a conviction that, while originality in Hindu astronomical writings suffered a setback in northern India from about the 13th century A.D., on account of historical reasons, there had been uninterrupted development thereof in remote corners like Kerala, which were far removed from the vortex of political and other tribulations. This conviction may be said to have been fully justified, for the present study has unearthed more than 750 Keralite texts on astronomy and mathematics and enabled the identification of more than 110 astronomers of the land.

Since only a very few of the said texts were available in print, let alone in reliable critical editions, the abovesaid study had to be extended to all its five related fields, to wit : (a) Documentation of the extensive manuscript material preserved, (b) Identification of the characteristics and lines of development of the discipline, (c) Biographical accounts of the astronomers and details about their works, (d) Critical edition of important and representative texts, and (e) Elucidation of the then current principles and practices.

The project envisaged was, indeed, of a magnitude too ambitious for a single individual to complete in any limited time. Perhaps, it requires a team of scholars and a much longer period. However, the following pages would show that substantial spadework has been done and considerable refined material presented through this Thesis, so as to render further work easy and rapid (Ch. I).

Thus, Chapter II of this Thesis, being the result of an intensive survey of the source materials, forms a fully referenced and documented Bibliography of Kerala and Kerala-based astronomical literature. Towards this, all potential collections of original palmleaf manuscripts in public institutions in India and in the private libraries of old families of astronomers in Kerala were systematically examined. The public institutions whose collections were studied with the above-said objective include the Oriental Research Institute and Mss. Library of the Kerala University, Trivandrum ; Govt. Oriental Mss. Library and the Adyar Library, Madras ; the Sanskrit College Library, Tripunithura; the S.V. Oriental Research Institute, Tirupati; the Sarasvati Mahal Library, Tanjavoor ; the Oriental Institute, Baroda ; the Oriental Research Institute, Mysore ; and the Vishveshvaranand Library, Hoshiarpur. The old family collections examined with the same objective include those at the Kanippayyoor Mana, Kunnamkulam ; Azhvancheri Tamprakkal Mana ; Malabar, Vayaskara Illam ; Kottayam ; Adhyan Namputiri Illam, Eravoor ; Svarnnattu Mana, Kudalloor ; Vatavoorkkottu Mana, Pavartti ; Elankunnappuzha Kovilakam, Narakkal ; and Katalayil Mana, Chavakkad.

Chapter III of the Thesis presents 'Some salient features of Kerala astronomy', which engendered the growth of the science in the land. Ch. IV draws attention to a number of 'Anticipations of modern mathematical discoveries' found in Keralite texts. An idea of the line of thinking and logical deduction of the Kerala astronomers which enabled these anticipations could be gleaned from a perusal of some of the works on mathematical and astronomical rationale edited in the later chapters of this Thesis, to wit, Ch. IX, *Rāśigolasphuṭānīti* ('True Moon computation on the sphere of zodiac'), Ch. X. *Tantrasaṅgraha*, especially the commentary *Yuktidīpikā* ('Lamp of astronomical rationale') thereon, Ch. XIV, *Sphuṭacandrāpti* ('Computation of the True Moon'), Ch. XVIII, *Grahaṇanyāyadīpikā*-

('Lamp of theory of eclipses'), and Ch. XXI, *Kriyā-kramakarī* ('Rationale of mathematical methods').

Ch. V sets out the 'Major trends in Kerala literature on *Jyotiṣa*'. It would be seen that the main bent of these works lies in adaptation and refinement, and in discovering novel methods and subtle corrections, all aimed at obtaining better results, whether it is the computation of the Moon or the planets, the eclipses or the shadow.

Thus, the three chapters III, IV and V, comprising of Section II of the Thesis, should, in effect, serve to inform the inquisitive student about the leading characteristics and lines of development of the discipline in the land.

Chapter VI of the Thesis, entitled 'Kerala astronomers', endeavours to give brief biographical sketches and details of the writings of all the Kerala astronomers who could be identified, numbering over 110. With a view to historical presentation, efforts have been made to fix the dates of these authors and give their biographical sketches chronologically. Again, all available manuscripts of each work of the several authors have been duly documented in the *Bibliography* (Ch. II), and the details of publication of any work that is available in print is supplied as footnotes to the biographical sketches themselves.

The last Section of the Thesis, comprising of fifteen chapters, VII to XXI, presents the critical editions of fifteen representative texts on astronomy and mathematics, some of them with commentaries. These texts have been selected on grounds of importance and edited scrupulously in accordance with the accepted principles of manuscriptology and textual criticism. Informative Introductions dealing with the author, the work and allied matters have been added to all the editions. In many cases, Translations have also been added. Indexes of verses, authorities cited, untraced quotations, etc. are a general feature of the several editions.

Equally, if not more important, are the short astronomical tracts added to the editions as Appendices. In the development of a practical science like astronomy, it is often the case that simpler redactions, corrections, supplements and complements come to be composed by the users of major texts. Indeed, it is these tracts that bear testimony to the living growth of the discipline, in general, and of the continued application of the teachings of the texts, in particular. A systematic effort was therefore made to trace, identify and correlate such supplementary tracts, often secreted in flyleaves and end-folios of palmleaf manuscripts, and to append them to the editions of the relevant texts. The edition of the *Sphuṭanirṇaya*, for instance, (Ch. XIV), carries as many as ten such tracts as Appendices. It might be of interest to note that to the fifteen editions included in this Thesis, about thirty subsidiary tracts have been added in this manner.

Of the texts whose editions are presented in the following pages, three are concerned with the celestial sphere and allied computations. The *Goladīpikā* of Parameśvara (A.D. 1360-1455) forms a good introduction to spherical astronomy and provides a comprehensive idea of the various theories and concepts on the subject (Ch. VII). The *Golasāra* of Nīlakaṇṭha (A D. 1444-1545) studies the celestial sphere from the point of view of astronomical concepts and observations (Ch. IX). *Rāśigolasphuṭanīti* carrying the views of Acyuta (A.D. 1560-1621) sets out a subtle and thitherto unknown correction for reduction to the ecliptic, being an anticipation of the same formula by the Danish astronomer Tycho-Brahe (*vide* Intro. to Ch. IX).

The *Tantrasaṅgraha* and the *Siddhāntadarpaṇa*, (Chs. X-XI), both by Nīlakaṇṭha (A.D. 1444-1545), are comprehensive astronomical texts. The elaborate commentary *Yuktidīpikā* added to the former is of special interest since it sets out in detail the rationale behind astronomical and mathematical methods and formulae.

Chapters XII and XIII, forming critical editions of Haridatta's *Grahacāranibandhana* (A.D. 638) and Parameśvara's *Dṛggaṇita* (A.D. 1431), are of prime interest in the history of Kerala astronomy in that they present the basic texts which promulgated the *Parahita* and *Dṛk* systems of astronomical computation in use in the country.

The *Sphuṭanirṇaya* of Acyuta (A.D. 1560-1621) enunciates advanced methods for the computation of the planets (Ch. XIV). *Sphuṭacandrāpti* and *Veṇvāroha* (Chs. XV, XVI), both by Mādhava of Saṅgmagrāma (A.D. 1340-1425) set out an ingenious method for reading off the true position of the Moon every 40 minutes.

Chapters XVII-XIX present critical editions of three works of Parameśvara (A.D. 1360-1455) on the computation of eclipses. While the first two, *viz.*, *Grahaṇamaṇḍana* and *Grahaṇāṣṭaka*, deal with the actual computation, the third *Grahaṇanyāyadīpikā* supplies the rationale behind the computations.

The *Candracchāyā-gaṇita* of Nīlakaṇṭha (A.D. 1444-1545) is representative of a class of texts aimed at the computation of the Moon from the gnomon's shadow cast by it and of the shadow from the computed Moon, for religious and social purposes (Ch. XX).

The *Kriyākramakarī* of the 16th century astronomers Śaṅkara and Nārāyaṇa (Ch. XXI), is again, as instructive as it is elaborate, and expounds in detail the rationale of mathematical methods and formulae. Its importance lies also in the fact that it brings together theories and formulae current in the floating tradition of the land, for instance on the value of π and allied matters.

Forming part of a long-range programme undertaken several years ago, the editions of the texts, as also the other sections included in this volume have, partly, been issued earlier in print, and have now been brought together in the form of the present Thesis to fulfil one of the purposes for which they were originally intended. This circum-

stance has had its good as also adverse effects. For one thing, there has been some repetition in the introductory matter prefixed to some of the editions. The several indexes continue to pertain to individual texts instead of to the Thesis as a whole. These shall have to be taken care of when a consolidated edition of the texts is undertaken, in due course.

The present Thesis is submitted with the full consciousness of the fact that what is presented here is but a fragment of the vast material which has been identified and documented in Ch. II. Even the material presented here is capable of being studied in depth, a matter which is being pursued by the present writer. But, all the same, it is offered in this form in the hope that it would be substantial enough to bring home to scholars an idea of the rich potential awaiting to be exploited and thereby create in them an incentive in that direction.

It now remains for me to express my deep sense of gratitude to the authorities of the several institutions and custodians of the private collections, enumerated earlier, who afforded me the necessary facilities for studying the manuscripts and other reference materials kept under their control. My grateful thanks are due also to the several scholars and friends who gave encouragement, help and advice in my studies and investigations. Among them a special mention deserves to be made of Prof. T. S. Kuppanna Sastri, Madras, Shri Rama Varma Maru Thampuran, Cochin, and Shri P. K. Koru, Pavartti. I take this occasion to express my indebtedness also to the Heads of the institutions to which I was officially attached, *viz.*, the Oriental Manuscripts Library, Trivandrum, the Deptt. of Sanskrit, University of Madras, and the V.V.R. Institute and V.V.B.I.S. & I.S., Panjab University, Hoshiarpur, for encouraging me to carry on my individual research work without detriment to my official duties.

K.V. SARMA

ROMAN TRANSLITERATION OF DEVANĀGARĪ

VOWELS

Short :	अ	इ	उ	ऋ	लृ (and ळ)		
	a	i	u	ṛ	ḷ		
Long :	आ	ई	ऊ	ए	ओ	ऐ	औ
	ā	ī	ū	e	o	ai	au

Anusvāra : ं = ṁ

Visarga : : = ḥ

Non-aspirant : ऽ = '

CONSONANTS

Classified :	क्	ख्	ग्	घ्	ङ्			
	k	kh	g	gh	ṅ			
	च्	छ्	ज्	झ्	ञ्			
	c	ch	j	jh	ñ			
	ट्	ठ्	ड्	ढ्	ण्			
	ṭ	ṭh	ḍ	ḍh	ṇ			
	त्	थ्	द्	ध्	न्			
	t	th	d	dh	n			
	प्	फ्	ब्	भ्	म्			
	p	ph	b	bh	m			
Un-classed :	य्	र्	ल्	व्	श्	ष्	स्	ह्
	y	r	l	v	ś	ṣ	s	h
Compound :	क्ष्	त्र्	ज्ञ्					
	kṣ	tr	jñ					

CHAPTER I

ASTRONOMICAL TRADITION OF KERALA

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Genesis of Indian astronomy

Astronomical investigations are a natural corollary to man's inquisitiveness and natural efforts to unravel the secrets of natural phenomena and are as old as human civilization itself. The origins of astronomy in India have to be traced to the intelligent interest that the brilliant starlit sky and the heavenly bodies had excited in the Vedic seer in the dim past, and the assiduous observations with which he followed the recurring natural phenomena like day and night, the seasons, the phases of the moon, the transit of the heavenly bodies, the eclipses, etc. From the fourth millennium B.C. or earlier, when the Vedas, which are the most ancient Indian literature, began to be composed, several astronomical observations came to be recorded, some significant astronomical speculations broached upon and some generalisations attempted. Such professionalists as *Nakṣatradarśa* 'star gazer'[1] and *Gaṇaka* 'calculator'[2] who practised the *Nakṣatravidyā*, 'science of the stars'[3] came into being in due course.

Pre-scientific and Scientific astronomy

The development of astronomical science in India could, advantageously, be studied under two heads, *viz.*, Pre-scientific astronomy and Scientific astronomy. Scientific astronomy might be said to have commenced when the fundamentals of the science had been established and strict rules and procedures of computation had been formalised. The system could then grow on a rational basis. In the history of astronomy, the scientific period could be said to have started towards *c.* A.D. 500, with Āryabhaṭa (born A.D. 476), from when on there has been a long line of recorded astronomical tradition reaching down to the

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1. *Cf. Yajurveda, Vājasaneyi-Saṁhitā*, 3.10 ; *Taittirīya-Brāhmaṇa*, 3.4.4.

2. *Cf. Yajurveda, Vāj.Saṁ.*, 30.20 ; *Tait.Br.*, 3.4.15.

3. Mentioned along with the other disciplines of study in the *Chāndogya Upaniṣad*, 7.1.2.4.

17th century in general and right up to the 19th century in remote corners of India like Kerala. This period of nearly one and half millennia produced several lines of astronomers who maintained the tradition and also made substantial original contributions, some of which were re-discovered, much later, in modern astronomy. The attainment of the scientific stage, however, necessarily presupposes an era of observation and speculation, extending over a long period of time. During this period, queries would have been raised and explanations offered, theories propounded, verified and revised, rules formulated and tried, and procedures devised and short-cuts sought for. This empirical stage in the evolution of the discipline in India might be termed as the Pre-scientific period of Indian astronomy.

Sources of the Pre-scientific age

Chronologically, this period in Indian astronomy should be taken to commence from when the Vedic hymns began to be composed towards *c*. 4000 B.C. and to have lasted till A.D. 500 when, as indicated before, scientific astronomy emerged. The Vedic literature produced during this period is voluminous, though only stray passages therein are wholly astronomical in content. This literature includes, primarily, the four Vedic *Saṁhitās, viz., Ṛgveda, Yajurveda, Sāmaveda* and *Atharvaveda*, in their several recensions, being the collection and presentation in a classified form, towards 2500 B.C., of the large mass of floating Vedic hymns; the extensive elucidatory literature thereon, called the *Brāhmaṇas*, and the supplementary texts thereto, called *Āraṇyakas* ; the philosophic expositions called *Upaniṣads* ; and the six *Vedāṅgas*, composed with the purpose of inculcating the correct method of recitation and the right way of understanding the Vedic texts, and setting out the exact performance and punctual observance of the Vedic rituals. Two of these six *Vedāṅgas*, *viz*., *Jyotiṣa* and *Kalpa*, the latter in its last section called *Śulba*, are of particular importance in the study of the growth of astronomy in India. The former, *viz*., *Vedāṅga-Jyotiṣa*, being short texts attached to the *Ṛgveda*, *Yajurveda* and the *Atharvaveda* sets out certain definitive aspects of Vedic astronomy, while the latter, *viz*., the *Śulbasūtras*, being mensuration manuals for the construction of different types of fire altars, such as *Baudhayāna*, *Āpastamba*, *Kātyāyana*, *Mānava*, *Maitrāyaṇīya*, *Vārāha* and *Vādhūla*, codify the practical side by Vedic astronomy. The two epics of India, *viz*., the *Mahābhārata* and the *Rāmāyaṇa*, which too, belong to the pre-scientific age of Indian

astronomy, contain several useful references. So also the earlier Purāṇa texts. The Jainas had a fervour for mathematics and in some of their canonical texts is to be found a section named *Gaṇitānuyoga* 'system of calculation'. Among the Jaina texts which contain mathematical and astronomical material might be mentioned *Sūryaprajñapti*, *Jambūdvīpa-prajñapti*, *Sthānāṅgasūtra*, *Uttarādhyayana-sūtra*, *Bhagavati-sūtra*, *Anuyoga-dvāra-sūtra* and the *Bhāṣya* by Umāsvāti on the *Tattvārthādhigama-sūtra*. Last to come in this period are the five systems of astronomy, *viz.*, the *Paitāmaha-siddhānta*, *Vāsiṣṭha-siddhānta*, *Saura-siddhānta*, *Romaka-siddhānta* and *Pauliśa-siddhānta*, whose original texts are not available now, but whose tenets have been set out by Varāhamihira in his *Pañca-siddhāntikā* (505 A.D.).

Āryabhaṭa and Scientific Indian astronomy

Scientific astronomy can be said to have been enunciated in India by Āryabhaṭa I (*b.* A.D. 476) who flourished at Kusumapura (Modern Patna) through his two works, the *Āryabhaṭa-siddhānta* which is available only in the form of citations by later authors, and as summarised in the *Khaṇḍakhādyaka* of Brahmagupta, and the *Ārya-bhaṭīya*, a full-fledged work composed in A.D. 499. Āryabhaṭa was an observer *par excellance* and, as a result of his investigations, he revised the then current astronomical parameters, introduced new techniques in calculation and established Hindu astronomy on a scientific basis. An anonymous verse describes him as a great teacher who was born in Kusumapuri as the incarnation of the Sun in order to resurrect astronomy when the results arrived at by means of the '*Five Siddhāntas*' began to be erratic. *Cf.* :

सिद्धान्तपञ्चकविधावपि दृग्विरुद्ध-
मौढ्योपरागमुखखेचरचारक्लृप्तौ ।
सूर्यः स्वयं कुसुमपुर्यभवत् कलौ तु
भूगोलवित् कुलप आर्यभटाभिधानः ॥

The name of Āryabhaṭa is of particular significance to Kerala, for the astronomical tradition of Kerala is wholly based on the *Ārya-bhaṭīya*.

Āryabhaṭīya

The *Āryabhaṭīya*, couched in 121 aphoristic verses of deep import, is the earliest extant Indian treatise on scientific planetary

astronomy. Its first section, called *Gītikā-pāda*, sets out in 13 verses the basic definitions, the main astronomical parameters, the zero-point for the commencement of calculations, the positions of the apogees and the ascending nodes of the planets at the time of the author, the diameters of the earth and the planets, the obliquity of the ecliptic and the inclinations of the planetary orbits to the ecliptic and a table of sine-differences. The second section, *Gaṇita-pāda*, in 33 verses, is concerned with enunciations involving arithmetic, geometry and trigonometry. The third section, *Kālakriyā-pāda*, in 25 verses, gives the units of time, explains the motion of the planets by means of epicycles and enunciates the methods for the determination of the mean and true positions of the planets at any given time. The fourth section, *Gola-pāda*, in 50 verses, deals with the motion of the Sun, Moon and the planets on the celestial sphere and the computation and graphical representation of the solar and lunar eclipses.

Āryabhaṭa's contribution

Āryabhaṭa's contribution to algebra, trigonometry and astronomy are highly significant. Among them a special mention might be made of the theory of indeterminate analysis of the first degree, the value of π correct to four decimal places, the computation of the sine table, the use of the radian measure of 3438 minutes of arc, advanced astronomical parameters, the theory of planetary motion and the correct interpretation and computation of the eclipses.

Earth's rotation

More significant, perhaps, is the promulgation by Āryabhaṭa of the theory of the rotation of the Earth. Against the current view that the Earth was stationary at the centre of the Universe and that all heavenly bodies revolved round it, Āryabhaṭa held that the Earth rotated round its axis once in a sidereal day[1] and through an angle of one minute of arc in one *prāṇa* (equal to 1/6 of a *vināḍī*, or 4 sidereal

1. *Cf.*, क्ष्मावर्ताश्चापि नाक्षत्राः, 'The rotations of the Earth are sidereal days', *Āryabhaṭīya*, *Kālakriyā*, 5.

seconds),[1] while the stars were fixed in space.[2] The time for one sidereal rotation of the Earth at the above rate would work out to 23^h 56^m $4^s{\cdot}1$, while the corresponding modern value is 23^h 56^m $4^s{\cdot}091$. The accuracy of Āryabhaṭa's enunciation is remarkable.

Opposition to Āryabhaṭa

It is a highly interesting and, perhaps, instructive anecdote in the annals of Indian astronomy that the above theory of Āryabhaṭa is known to us from the writings of contemporary and later critics of Āryabhaṭa like Varāhamihira (A.D. 505), Brahmagupta (A.D. 628), Lalla (8th cent.), Śrīpati (A.D. 1039) and Bhāskara II (*b.* 1114), who

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1. *Cf.*, प्राणेनैति कलां भूः, *Āryabhaṭīya*, *Gītikā*, 6.

For other specific references by later authors to Āryabhaṭa's theory of the rotation of the Earth, *cf.* : (1) *Pṛthūdakasvāmī* (A.D. 860), Com. on the *Brāhmasphuṭasiddhānta* (*Gola*, 30) : *Ācārya-Āryabhaṭenāpi bhūbhramaṇam abhyupagatam. Lokabhayād Bhāskarādibhir* (Bhāskara I of A.D. 629) *anyathā matvā āryā vyākhyātā* ; elsewhere he says : *bhapañjaro sthiraḥ* ; *bhūr evā āvṛtyāvṛtya pratidaivasikau udayāstamayau sampādayati nakṣatragrahāṇām.*" (see Colebrooke's *Miscellaneous Essays*, vol. II, p. 344). (2) Udayadivākara (A.D. 1073), Com. on Bhāskara I's *Laghubhāskarīya* (i.32-33) : *bhūbhramaṇam apy Ācāryeṇa abhyupagatam, nakṣatrāṇām sthiratā ca* ; (3) Makkibhaṭṭa (A.D. 1377), Com. on Śrīpati's *Siddhāntaśekhara* (i. 39) : *bhūmiḥ prāṅmukhī bhramati.*

2. *Cf.* *Āryabhaṭīya*, *Gola*, 9-10 :

अनुलोमगतिर्नौस्थः पश्यत्यचलं विलोमगं यद्वत् ।
अचलानि भानि तद्वत् समपश्चिमगानि लङ्कायाम् ॥
उदयास्तमयनिमित्तं नित्यं प्रवहेण वायुना क्षिप्तः ।
लङ्कासमपश्चिमगो भपञ्जरः सग्रहो भ्रमति ॥

'Just as a man in a boat moving forward sees the stationary objects (on either side of the river) as moving backward, just so are the 'stationary stars' (*acalāni bhāni*) seen (by people) at Laṅkā (the hypothetical city at the equator), as moving exactly towards the west.

'(It also appears as if) the entire structure of the asterisms, together with the planets were moving exactly towards the west of Laṅkā, being constantly driven by the provector wind, to cause their rising and setting.'

severely criticise Āryabhaṭa's theory of the rotation of the earth. *Cf.*, for instance, the *Brāhmasphuṭasiddhānta*, (11.17) :

"If the Earth rotates through one minute of arc in one respiration (*prāṇa*), from where does it commence its rotation and where does it go ? And, if it rotates (on its axis, at the same place) why do not tall objects (like towers) topple down ?"

In the same vein, Lalla asks : "If the earth rotated (at such a terrific speed) how could birds in flight return to their nests, (for, by the time they returned, the trees on which the nests were would have sped away), missiles thrown vertically upwards would fall towards the west and the clouds would always be moving to the west. If it is argued that the earth is moving at a slow speed, how could it, then, go round the universe in a day."[1]

Decline and resurgence of the system

Severe criticism, both veiled and open, against the system of Āryabhaṭa, coming as it did from acknowledged authorities, like Brahmagupta, Varāhamihira and Śrīpati, should have bedevilled not only the laymen but also the professionals, and the study of Āryabhaṭan system gradually declined in North India. And, with the wide popularity gained by the great works of Bhāskara II (*b.* 1114) who followed in the wake of

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1. यदि च भ्रमति क्षमा तदा स्वकुलायं कथमाप्नुयुः खगाः ।
इषवोऽभिनभः समुज्झिता निपतन्तः स्युरपांपतेर्दिशि ॥
पूर्वाभिमुखे भ्रमे भुवो वरुणाशाभिमुखो व्रजेद् घनः ।
अथ मन्दगमात् तदा भवेत् कथमेकेन दिवा परिभ्रमः ॥

Śiṣyadhīvṛddhida, *Golādhyāya*, 7, *Mithyājñānādhyāya*, 42-43

For similar criticism, see Varāhamihira's ***Pañca-Siddhāntikā*** (13.6-7), Śrīpati's *Siddhānta-śekhara* (*Gola.*, 15-17) and Bhāskara II's ***Siddhānta-śiromaṇi***, (*Madhyamādhikāra*, *Kālamānādhyāya*, 13-14).

It is a sad commentary that, in the face of these apparently insurmountable criticism, the followers of Āryabhaṭa abandoned the theory, and effected two minor alterations in the text of the *Āryabhaṭīya* towards making it unoffending ; *viz.*, the word *bham* ('sidereal sphere') for *bhūḥ* ('earth') in the passage *prāṇenaiti kalām bhūḥ*, (*Gītikā*, 6), and *bhāvartāś cāpi* ('revolutions of the asterisms') for *kvāvartāś cāpi* ('rotations of the earth') in *Kālakriyā*, 5.

Brahmagupta and Śrīpati, the Āryabhaṭan system was practically effaced from North India. One does not come across a North Indian manuscript of the *Āryabhaṭīya*, let alone a North Indian commentator, after the time of Bhāskara II.

The Āryabhaṭan system, however, emerged with increased vigour south of the Vindhyas. The superiority of the astronomical parameters and the novel innovations of Āryabhaṭa had given rise to a 'School of Āryabhaṭan astronomy', the followers of which called themselves *Āśmakīya-s* ('Advocates of the school of the Aśmaka author, *viz.*, Āryabhaṭa') or *Bhaṭaśiṣyas* ('Students of Ārya-Bhaṭa). Scholars of South India, comprising of Karnataka, Andhra, Tamilnadu and Kerala, avidly took to the study of the *Āryabhaṭīya* and produced several commentaries[1] and a mass of literature based on the system of Āryabhaṭa.[2] It is specially noteworthy that the several systems of almanac computation in the said regions current during the mediaeval times were based on the *Āryabhaṭan* manuals.[3]

Tradition of the Āryabhaṭīya in Kerala

Of the several cultural centres in ancient and mediaeval India, Kerala stands out as the bastion of the Āryabhaṭan School of Hindu astronomy. Situated at the southernmost tip of India, far removed and free from the political troubles and turmoils that affected most of the other parts of the land during mediaeval times, this part of the country had the opportunity to develop, in an uninterrupted manner, such technical disciplines as medicine, mathematics and architecture.

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1. For commentaries on the *Āryabhaṭīya* by astronomers of Andhra, Karnataka, Maharashtra, Tamilnadu and Kerala, see *Āryabhaṭīya*, Cr. ed. with Introduction, English Translation, Notes and Comments, by K. S. Shukla and K. V. Sarma, (Indian National Science Academy, New Delhi, 1976), Introduction, pp. xxxv-lvii.

2. For a selection of these works, see *ibid.*, pp. lvii-lxii. For the works composed exclusively by Kerala astronomers, see below, Ch. II. *A Bibliography of Kerala and Kerala-based astronomy and astrology*.

3. For *Vākyakaraṇa*, a 14th cent. manual used in the Tamil-speaking region of India, see the critical edition thereof, with Commentary, Analysis, Notes and Tables, by T.S.K. Sastri and K.V. Sarma, (K.S. Research Institute, Madras, 1962).

In this wake, Kerala adopted the basic tenets and practices of Āryabhaṭan astronomy and also preserved and developed its tradition for more than thirteen centuries todate—a view that can be postulated for several reasons. Thus, the bulk of the known manuscripts of *Āryabhaṭīya* are from Kerala, in palmleaf, inscribed in the Malayalam script.[1] Most of the known commentaries on the *Āryabhaṭīya* are authored by astronomers of this part of the country. Thus, of the nearly twenty commentaries on the work known, as many as twelve are by Kerala authors.[2] Practically every astronomical text produced in the land bases itself on the teachings of Āryabhaṭa. The efforts of Kerala mathematicians have been directed also towards the revision, correction and supplementation of Āryabhaṭan astronomy with a view to arriving at more accurate results. The extensive popularity of Āryabhaṭa in Kerala has tempted some scholars to take him as a native of Kerala, who, however, propagated his teachings at Kusumapura (Pāṭaliputra, modern Patna) in Northern India.[3] And, the region of Aśmaka, referred to in later literature as the place from where he hailed, has been taken as a Sanskritisation of the Malayalam place-name Koṭuṅṅallūr in Central Kerala.[4]

Āryabhaṭan astronomy appears to have become popular in Kerala soon after its promulgation by Āryabhaṭa towards A.D. 500. Kerala texts on the subject attest to its practice and successive revision of parameters, resulting in different systems of computation, at different periods.

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1. Nearly 120 mss. of *Āryabhaṭīya* have been recorded in the *New Catalogus Catalogorum of Sanskrit and allied works and authors*, vol. II, (Madras University, 1966), p. 171. Most of these are of Kerala origin.

2. For details see below, Ch. II. *A Bibliography of Kerala and Kerala-based astronomy and astrology*.

3. See, for example, K. Damodaran Nambiar, 'Āryabhaṭan', *Mātṛbhūmi*, (Malayalam Weekly, Kozhikode Kerala), Oct. 18, 1970, pp. 15-16, 42.

4. The equation here is : *koṭum-kal* (hard black-stone=*aśmā*)+ *ūr* (place).

Dṛkkaraṇa, an astronomical manual composed in Malayalam verse in A.D. 1607-08,[1] throws some interesting light in this direction. On the advent of the *Āryabhaṭīya*, the *Dṛkkaraṇa* records in *Pariccheda* 1 :

paṇṭuḷḷa gaṇitajñanmār connatoṭṭu paraññīṭām |
kalyabdam trisahasrattil param cennuḷḷa nāḷilu ||5||
ottuvannīṭumārilla grahaṇādikaḷ onnume |
karaṇaṅṅaḷum oṭṭīṭā siddhāntaṅṅaḷum oṭṭiṭā ||6||
tadā hy Āryabhaṭo nāma gaṇakas tv abhavad bhuvi |
'jñānatuṅge'ti kalyabde jātanāy avanītale ||7||
girituṅgeti kalyabde gaṇitam nirmitam param |
śāstram Āryabhaṭīyākhyam tasmin paryayam uktavān ||8||

* * * *[2]

iva annekkupāyena kuṟacciṭṭum kareṭṭiyum ||12b||
kalyādi-dhruvam illāte oppiccān annu paryayam ||13a||

'Now, I shall set out in brief what the early astronomers enunciated. Before Kali 3000, the eclipses and other observed phenomena did not tally with the astronomical manuals or the Siddhāntas. (5-6)

'Then, in the Kali year *jñānatuṅga* (3600=A.D. 499) an astronomer by name Āryabhaṭa was born in this world. (7)

'In the Kali year *girituṅga* (3623=A.D. 522) was his work *Āryabhaṭīya* composed and therein he stated the revolutions (of the planets). (8)

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1. This work, divided into ten sections called *paricchedas*, appears to have been written by Jyeṣṭhadeva, author of the astronomical treatise *Yuktibhāṣā*. The date of the composition of *Dṛkkaraṇa* is given in its concluding line thus :

Kolambe 'barhisūnau' vihagagatiyatum nokki itthạm camappū |

'Compute (as instructed) and subtract the planetary positions for Kollam year *barhisūnu* (783) (=A.D. 1607-8).'

2. Here are given the parameters of the *Āryabhaṭīya*.

'He had adjusted these revolutions by reduction and addition in such a way that there was no zero-correction at the beginning of Kali.' (12b-13a).

The Parahita system of Haridatta (A.D. 684)

The first major revision, in Kerala, of the astronomical constants enunciated by Āryabhaṭa was effected in A.D. 683-84 by a set of astronomers who had gathered for the twelve-yearly *Māmāṅkam* (*Mahāmagha*) festival at the religio-educational centre of Tirunāvāy in northern Kerala. The revised system, which came to be known as *Parahita-gaṇita* has been enunciated by Haridatta in his *Grahacāranibandhana*[1] and *Mahāmārganibandhana*.[2] The *Dṛkkaraṇa* records this event in the following words :

pinne igganitattinnu nīkkam kaṇṭitu bhūtale |
'mandasthale'ti kalyabde 'tanute'ti śakābdake ||18||

palarum gaṇitajñanmār kūṭe nokkīṭṭu veccatu |
Kalyabdād 'girituṅgo'nāt śeṣam veccu perukkaṇam ||19||

* * * *[3]

pērum Parahitam ennu, gaṇitam sūkṣmam ennitu |
iti niścitya palarum ācariccavanītale ||25||

'In course of time, deviations were observed in (the results arrived at by) this computation (18a). Then, in the Kali year *mandasthala* (3785=A.D. 684), equivalent to Śaka *tanutā* (606), several astronomers gathered together and devised by observation, (a system), wherein (the correct number of revolutions were to be found) by multiplying the current Kali year-*minus*-'*girituṅga*' (Kali 3623, *viz.*, the Āryabhaṭan epoch) (by the yearly *Bhaṭābda* or *Śakābda* corrections enunciated). (18b-19).

1. For a Critical edition of this work with Introduction, and Appendix, see below, Ch. XII. See also K. V. Sarma, 'Parahita-gaṇitattinṭe mūlagrantham', *Mātṛbhūmi*, (Malayalam weekly, Kozhikode), Oct. 10, 1954.

2. This is apparently the full-fledged theoretical treatise of the *Parahita* system, while the *Grahacāranibandhana* is only its work manual. Manuscripts of the work are yet to come to light, but the work is known through a reference in *Grahacāranibandhana*, 2.44.

3. Here is given the well-known *Bhaṭābda* or *Śakābda* correction.

'This system was termed *Parahita* and many followed it, assuring themselves of its accuracy.' (25)

The promulgation of *Parahita*, being the revised Āryabhaṭan system, is recorded thus, in another Keralite astronomical work, the *Sadratnamālā* of Śaṅkara-varman (A.D. 1800-38) :[1]

Ācāryāryabhaṭa-praṇīta-karaṇam prāyas sphuṭam tat kalau
'gotrottuṅga'mitābdake vyabhicaran Brahmādi-siddhāntake |

* * * *

dṛgavaiṣamyavaśāt 'mahāsthala'mite kalyabdake niścitaḥ
saṁskārō vibudhair yataḥ Parahitatvam teṣu vīneṣv ayam ||

(*Prakaraṇa* 6, verses 1, 3)

'Ācārya Āryabhaṭa's astronomical treatise gave well-nigh accurate results in Kali year '*gotrottuṅga*' (3623=A.D. 522), while the (earlier astronomical) *siddhāntas* ascribed to Brahmā etc. were tending to be inaccurate.

'(When Āryabhaṭan results, too, tended to be inaccurate as exemplified by their) not tallying with observation, a correction was decided upon by astronomers (for all planets) other than the Sun. (And the revised system was known as *Parahita*) because it was acceptable to all.'

Dṛk system of Parameśvara (A.D. 1431)

The parameters of the *Parahita* system were revised by Parameśvara (A.D. 1360-1455) through his reputed work *Dṛggaṇita*.[2] The *Dṛkkaraṇa* describes its advent thus :

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1. Edited (incompletely) in the Malayalam monthly *Kavanodayam*, (Kozhikode, vol. 16, 1898). For Mss., see Nos. 8322-B, C. 2136 of the Kerala Uni. Mss. Library.

2. For a Critical edition of this work with Introduction and Appendix, see below, Ch. XII. The date of its composition is given towards the end of the work in the verse :

evam Dṛggaṇitam śāke triṣuviśva-mite kṛtam |
Paramādiśvareṇaitat prāyo bhavati dṛkṣamam ||II. 46||

'The *Dṛggaṇita* has, thus been composed in *śaka* 1353 (=A.D. 1431) by Parameśvara (*lit.*, '*Iśvara*' prefixed by the word '*Parama*'). (The

cirakālam kazhiññappōḷ nīkkam vaḷare vannitu |
'raṅgaśōbhā nu'-kalyabde kaścid vipravaras tadā ||26||
paścimāmbōdhi-tīrattu ninnu nōkkīṭṭu vaccatu ||27a||

'When a long time had elapsed, there occurred substantial deviation. (26a)

'Then, (Parameśvara), a noble brāhman, residing on the coast of the western ocean revised it (*i.e.*, the *Parahita* system) by means of (astronomical) observations, in the Kali year *raṅgaśōbhānu* (4532=A.D. 1431).' (26b-27a)

Revision by Nīlakaṇṭha (A.D. 1444)

The *Dṛkkaraṇa* specifies the planetary revolutions depicted in the *Tantrasaṅgraha* as pertaining to '12 years later' than those of the previously mentioned revision, *i.e.*, it refers to A.D. 1443-44, which is the year of birth of the author of the work, Nīlakaṇṭha Somayāji.[1] *Cf.* :

dvādaśābdam kazhiññiṭṭu Tantrasaṅgraham ennatu ||27b||

'Twelve years later (were determined the planetary parameters depicted in) the *Tantrasaṅgraha.*' (27b)

Revision in Dṛkkaraṇa

The *Dṛkkaraṇa* then records its own revision promulgated in A.D. 1607 :

tasmin paryayavum pinne sthūlamāyiṭṭu colliyāl |
'jasustave'ti[2] *kalyabdē tuṭarnnār avanītale ||28||*

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results obtained hereby will) tend to be the same as those by observation.'

On the system and the work, see the text and the Introduction below in Ch. XII. See also, K.V. Sarma, 'Parameśvarācāryaruṭe Dṛggaṇitam', *Mātṛbhūmi*, (Malayalam Weekly, Kozhikode), Aug. 28, 1960, pp. 19-21.

1. On the date of Nīlakaṇṭha, see below Ch. X, Critical edition of the *Siddhāntadarpaṇa* of Nīlakaṇṭha Somayāji, Introduction.

2. The manuscript reads *vasusmareti*, which is, obviously, corrupt. The emendation made fits in with the context.

paścimāmbōdhitīrattu ninnu muppatu varṣavum |
nokkīṭṭu gaṇakanmārum 'janasevā nu'-vatsare ||29||
sūkṣmam varutti nirmiccār gaṇitāgamam annavar |
iniyum kaṇṭukoḷḷēṇam cirakālād varunnatu ||30||

'The revolutions given therein (*i.e.*, in *Tantrasaṅgraha*), too, being found to be imperfect, observations were continued by the astronomers on the west coast for thirty years, from the Kali year *jasustava* (4678 = A.D. 1577) to the Kali year *janasevā nu* (4708 = A.D. 1607) and, by observation, the astronomical tradition was revised accurately. (28-30a)

'Henceforward, too, (the deviations) that would occur should be carefully observed (and revisions effected).' (30b)

This is followed, by the statement of the parameters, in the beginning of the next *pariccheda,* verses 1-6.

The *Sadratnamālā* also records this revision in the following verse :

pratyakṣataḥ Parahite gaṇite'pi bhedam
dṛṣṭvā kalau 'janasabhā'-mita-vatsarānte |
rāddhāntite tu gaṇakair gaṇitāgame yad
dṛksāmyagāni karaṇādi tad atra vakṣye || (VI.43)

'Since differences between (values derived by) the *Parahita* computation and observation were noted, certain revisions were enunciated in the astronomical tradition by astronomers in Kali year *janasabhā* (4708 = A.D. 1607). I shall set out here those practices which tend to give results akin to those by observation.'

Then are given the new parameters and computational methods.

Comparative study of the revisions

The parameters according to the mediaeval revisions mentioned above are being set out in the following table, with the textual verses reproduced as footnotes, for verification. This should enable a two-pronged enquiry being made into the subject—first towards working out the methods by which each revision was made and secondly towards determining the relative merit of the succeeding revisions.

TABLE OF PARAMETERS

Source	Date A.D.	Sun	Moon	Moon's Apogee	Moon's Node	Mars	Mercury	Jupiter	Venus	Saturn	No. of days per *yuga*
[1]*Ārya-bhaṭīya*	499	43,20,000	5,77,53,336	4,88,219	2,32,226	22,96,824	1,79,37,020	3,64,224	70,22,388	1,46,564	1,57,79,17,500
[2]*Parahita* of Haridatta	683	,,	,, 314.2	,, 121 9	,, 307.3	,, 862.3	,, 378.0	,, 184.0	,, 257.8	,, 581.0	,,
[3]*Dṛggaṇita* of Parameś-vara	1431	,,	,, 321.009	,, 123.229	,, 297.832	,, 862.959	,, 072.112	,, 172.296	,, 270.775	,, 626.695	,, 517.019
[4]*Tantra-saṅgraha* of Nilakaṇṭha	1444	,,	,, 320	,, 122	,, 300	,, 864	,, 048	,, 180	,, 268	,, 612	,,
[5]*Golasāra* of Nilakaṇṭha	c.1486	,,	,, 320	,, 120	,, 300	,, 864	,, 040	,, 180	,, 270	,, 600	,,
[6]*Siddhānta-darpaṇa* of Nilakaṇṭha	c.1500	,,	,, 332.321	,, 123.318	,, 226.745	,, 862.137	,, 120.175	,, 160.611	,, 270.552	,, 571.016	,, 839.500
[7]*Dṛkkaraṇa*	1607	,,	,, 320	,, 122	,, 298	,, 863	,, 100	,, 166	,, 272	,, 612	,,

Modern works

It would be instructive to note that the periodical revision of astronomical computation has been continued in Kerala till recent times.

Footnotes to page 14 :

1. *Āryabhaṭa's* parameters :

yugaravibhagaṇāḥ khyughṛ, śaśi
cayagiyiṅuśuchlṛ, ku ṅiśibuṇlṛkhṣṛ prāk |
śani ḍhuṅvighva, guru ghri-
cyubha, kuja bhadlijhnukhṛ, bhṛgubudhasaurāḥ ||
candrocca ṛjuṣkhidha, budha
suguśithṛna, bhṛgu jaṣabikhucchṛ, śeṣarkāḥ |
buphinaca pātavilomā
budhāhny ajārkodayācca laṅkāyām ||
(*Āryabhaṭīya, Gītikā*, 3-4)

nānājñānapragalbhas, tilabalamasusūkṣmam,
dhayed rājadambho,
bhadro danto dharendro, niranusṛgadhisaukhyam,
variṣṭhobhiṣaṅgaḥ |
dordaṇḍāgredrināṭho, viṣamitavipinam,
candrarekhāmbukhinne-
tyarkādeḥ paryayās syuḥ, kṣitidinam
anṛśaṁsaḥ kaḷārthī sa martyaḥ ||

(In *Kaṭapayādi* notation, *Karaṇapaddhati* of Putumana Somayâji, 1. 3)

2. *Bhaṭābda*-corrected parameters : The *Parahita* manuals contain only the correction but not the corrected parameters. These calculated figures are taken from T. S. K. Sastri and K. V. Sarma, *Vākyakaraṇam*, (Madras, 1962), Introduction, p. xii.

3. *Dṛggaṇita* parameters (for the *Kalpa*)

anūnanūtnānanarāgabhinnaṁ, dhanaṁ nṛpendrāṅgaguṇaṁ susūkṣmam |
dharmādhirantoditadhīraratnaṁ, priyāparicchinnasugandhasevyaḥ ||
coḷendrarasā kavitāṅganānāṁ, māṁsārthināṁ sūtrakharo nṛsaṁjñaḥ |
śuddhāntacitrocitabhāgyanūtno, dhātrīphalaṁ praśyadaher vanāni ||
rogādasādhuḥ kharagīranūnaṁ, sūryādikānāṁ bhagaṇādi kalpe |
krameṇa sūryendukujendujeḍyasitāsitendūccavidhuntudānām ||
dhanyā nu sā kāmasukeḷisārthā mānyā nu kalpe dharaṇīdinānī |

The point might be illustrated by three works on the subject composed during the last few decades, all in Sanskrit, employing revised methodologies and incorporating novel corrections, some of them based on

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(From *Pañcabodham Bhāṣā*, ed. by Kanippayyoor Śaṅkaran Nampūtirippāḍ, 2nd edn., Kunnamkulam, M.E. 1107, App., pp. 252-53).

4. *Tantrasaṅgraha* parameters :

divyābdānāṁ sahasrāṇi dvādaśaikam caturyugam /
sūryasya paryayās tasmād ayutaghnaradārṇavāḥ //I. 15//

khāśvīdeveṣusaptādriśarāś cendoḥ, kujasya tu /
vedāṅgāhirasāṅkāśvikarā, jñasya svaparyayāḥ //16//

nāgavedanabhaḥsaptarāmāṅkasvarabhūmayaḥ /
vyomāṣṭarūpavedāṅgapāvakāś ca bṛhaspateḥ //17//

aṣṭāṅgadasranetrāśvikhādrayo bhṛguparyayāḥ /
bhāskarāṅgarasendrāś ca śaneḥ, śaśyuccapātayoḥ //18//

netrārkāṣṭāhīvedāś ca, khakharāmaradāśvinaḥ /
khakhātyaṣṭigosaptasvareṣuśaśino yuge //19//
savanā divasāś cārkṣā mārtaṇḍabhagaṇādhikāḥ /20a/

5. *Golasāra* parameters :

viṣṇupadārthātyaṣṭyaṅkādrisvaraśarabhuvo dināni bhuvaḥ /
yugadaśamāṁśabhavāny atha sūryādīndūccapātabhagaṇāś ca
//I. 2//

khatrayadantāmbudhayo, yamāgnipuṣkaraśararṣiśailaśarāḥ /
ṣaḍahiṣaḍaṅkākṛtayo, vedakhamunipuṣkarāṅkaśailabhuvaḥ //3//

dhṛtyabdhirasahutāśaḥ, śailākṛtyaśvīviṣṇupadamunayaḥ /
vīyadaṅgatarkamanavo, yamacandragajāhivārīdhayaḥ //4//

gaganāgnīdantayamalāny ete yuktyā samuddiṣṭāḥ 5a

6. *Siddhāntadarpaṇa* parameters :

koṭighnaradavedāḥ prāk kalpe sūryasya paryayāḥ /
bhūdantaradadeveṣusaptādryarthā vidhoḥ, kṣīteḥ //I. 2//

khakheṣugoguṇāṣṭāśvāgnyśvidvyaṣṭaśarendavaḥ /
saptāgnyekāśviṣaṇṇāgarasāṅkākṛtayo 'sṛjaḥ //3//

svavṛtte 'rthāśvabhūkhārkādryagnyaṅkātyaṣṭayo viduḥ /
guror īśāṅgakhāṅgaikavedāṅgaśikhinaḥ, kaveḥ //4//

modern astronomy. The *Gaṇitanirṇaya* of Puliyoor Purushottaman Namputiri is an extensive treatise in about 700 verses, divided into ten chapt rs [1] The work takes the end of the Kali year 5,000, equivalent to April 13, 1899, as the epoch and presents the several computations in the traditional fashion. Numerous corrections based on modern astronomy have been incorporated in the Sanskrit verses, including 13 corrections for the Moon.

The *Gaṇitaprakāśikā* of K.V.I. Rama Potuval[2] is another modern astronomical manual which, too, takes Kali 5000 (A.D. 1899) as the epoch. In seven chapters containing 265 verses, the author aims at composing a treatise closely following the Keralite method of presentation but adopting new corrections so as to arrive at modern results.

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dvīṣvarthābhrabhanetrākṣikhāgā, laṅkodayācchaneḥ |
nṛpāśāśveṣu tarkendrā, bhuvo 'nye vārapā grahāḥ ||5||

7. *Dṛkkaraṇa* parameters :

arkādīnām paryayaṅṅal kevalaṁ sūkṣmam āyava |
jñāninām namrago bhānuḥ paryayo 'rkasya bhāṣitam ||II. 1||

nīralolormisatsoma candrasya bhagaṇānvayaḥ |
kujasya paryayo jñeyo gītajñas tāḷarandhranut ||2||

jñānāḍhyosau budhassevyas candrajasya prakīrtitaḥ |
vāgīśasya tathā jñeyas stutikṛd bhūtale nanu ||3||

kaver maṇḍalasaṅkhyās syus strīsukho rātrināthanut |
mandasya bhagaṇaṁ pinne śrīpatistadvapur nanu ||4||

paryayaś candratuṅgasya krūraḥ pādādibhir na nut |
durdharotra girīr aher arkādīnāñ ca paryayaḥ ||5||

nanāmasakaḷassārtheśāyino yannu bhūdinam |6a|

Sadratnamālā parameters :

jñānanighnaphalavin, narāṅgaguṇasatsamaṁ, rurupadārjavam
lakṣadātṛdhararād, anekasugaḷotsukaḥ, kṣitipabhūtalam |
śrīsakhīkhuranasā, sphuṭākṣataghaṭo, dadhatkharagaraḥ kramāt
bhāskarādibhagaṇāśca bhūdinam anīśasāyudhasusaṁśayaḥ ||VI. 44||

1. First edn., with Malayalam exposition by the author, V. V. Press, Quilon, 1932 ; Second edn., Quilon, 1952.

2. Desamitram Ptg. and Pub. Co., Canannore, 1950.

The *Śuddhadṛggaṇita* of V. P. Kunhikkanna Potuval[1] is still another manual of the said type. In eight chapters, containing 123 verses, this work, too, aims at accurate astronomical computation, the entire matter being presented on orthodox lines. It is interesting to note that the Indian Independence day, *viz.*, 15th August, 1947, has been adopted as the epoch of this work.

Theme of the present Thesis

The several chapters of this Thesis are intended to demonstrate the developments of the discipline of astronomy and mathematics in Kerala. Indeed, an inventory of the literature on the subject as documented in the next Chapter (Ch. II), extending over a hundred pages and presenting about 750 texts and 110 astronomers, would give an idea of the quantum of the work produced in the land. In the further chapters, an attempt has been made to give an idea of the nature and contents of this vast literature indicating its special characteristics (Chs. III-V), to provide a short historical account of the astronomers of the land (Ch. V), and to present the texts of fifteen major texts and thirty minor texts of the Kerala School of astronomy, critically edited from original palm-leaf manuscripts, with detailed introductions, translations and useful indices. These texts represent the different facets of astronomy and mathematics including those relating to : (1) the conception of and measurements on the Celestial Sphere, (2) Comprehensive texts, (3) Computational systems, (4) Planetary computations, (5) Computation of the moon, (6) Computation of the Eclipses, (vii) Computation of the Moon's Shadow and (viii) Mathematical rationale.

1. Pub., Jyotissadanam, Payyannur, 1956.

CHAPTER II

A BIBLIOGRAPHY OF KERALA ASTRONOMY

I. A BIBLIOGRAPHY OF KERALA ASTRONOMY AND ASTROLOGY

I. A BIBLIOGRAPHY OF KERALA ASTRONOMY AND ASTROLOGY

The Bibliogrphy of Kerala Jyotiṣa literature which is presented here is intended to document information on the manuscripts, studies and other references to Kerala authors and works in the allied disciplines of astronomy and astrology. The authors and works, with their dates and other essential identificatory or descriptive details, wherever necessary, have been arranged in one alphabetical sequence, the former being printed in thick roman type and the latter in bold italics. Since the works whose authors are known are automatically identified by those authors, the identification of anonymous works has been sought to be achieved through the supply of extracts of the initial lines of the respective works. Wherever some amplification seemed necessary, that has been supplied by extracting end-passages and colophons; this has been done also to set out hitherto unknown information.

The nature of the contents of the works has been indicated by adding, after the titles, their subjects such as: Astronomy (astron.), Saṁhitā, Tantra, Karaṇa (kar.), Eclipse computation (ecl.), Astrology (astrol.), Jātaka (jā.), Praśna (pra), Muhūrta (muh.), Prognostication, Natural astrology (nat. astrol.), arithmetic (arith.) etc. Sanskrit works are given no special indication to that effect but Malayalam works are distinguished by the addition of '(Mal.)' after their titles.

Often, different works bear a common name, (*e.g. Pañcabodha*), and all their manuscripts are bunched together in catalogues. In such cases, an attempt has been made to examine the manuscripts and identify them for this Bibliography and give against each distinct work the manuscripts relevent to it. Authors or works having a common name have been distinguished by the addition of I, II etc., to their names. So also the different commentaries on the same work. When a work does not give its title and therefore a title had to be assigned to it on the basis of its contents, the fact is generally indicated by the addition of '(?)' after the title. The symbol '(?)' is used also when a doubt is entertained about any matter. When the Kerala origin of a work is suspect that is indicated by adding '(Ker. ?)' to it.

Whenever it was felt that some purpose would be served by indicating the extent of a work, that has been done by noting the numbers of its sections or the number of *granthas* (32 syllables) it is comprised of.

The documentation of the manuscripts of works is intended more as indicatory than as exhaustive. When only a single manuscript or just a few manuscripts are known, the numbers of all the manuscripts have been noted. When, however, a large number of manuscripts of a work are known, the references to the relevent manuscripts catalogues alone are given or a few manuscripts noticed. Incomplete manuscripts are indicated by the addition of '(inc.)' to their numbers.

All the major repositories of Kerala manuscripts have been examined, either directly or through their catalogues of manuscripts, for the work on this Bibliography. The Kerala University Oriental Research Institute and Mss. Library, which, now, houses all the Trivandrum collections, is by far the largest of these repositories and had been most useful in the present work. In this Bibliography, references to the manuscripts germane to the University Collection[1] are given merely by their Ms. numbers, with no other indication. The numbers of the manuscripts belonging to the erstwhile Curator's Office Collection[2] are prefixed with 'C', those of the Curator's Office (Malayalam) Collection,[3] with 'CM', the Loan Collection with 'L', the Maharaja's Palace Collection,[4] with 'P', the Palace Malayalam Collection,[5] with 'PM', Transcripts Section with 'T' and Transcripts (Malayalam) Section, with 'TM'. Of the other collections, that of the Adyar Library and Research Centre[6] is indicated by 'Ad', the Oriental Institute, Baroda,[7] by 'Baroda',

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1. *Alphabetical Index of Skt. Mss. in the Univ. Mss. Library, (Ker.)*, Trivandrum, 2 vols., 1937, 1965; *Index of Malayalam Manuscripts, (Ker. Mal.)*, Trivandrum, 1951.

2. A *Des. Cata. of Skt. Mss. in the Curator's Office Library*, Trivandrum, 10 vols., 1937-41.

3 *Do. of Mal. Mss.*, Trivandrum, 3 vols., 1941.

4. *A Des. Cata. of Skt. Mss. in H. H. the Maharaja's Palace Library*, Trivandrum, 8 vols., 1937-38.

5. *Do. of Mal. Mss.*, Trivandrum, 2 vols., 1939.

6. *Alphabetical Index of Skt. Mss. in the Adyar Library*, Madras, 1944.

7. *An alphabetical list of Mss. of the Or. Institute*, Baroda, 2 vols., 1942, 1950.

the Government Or. Mss. Library, Madras,[1] by 'Mad.', S.V. Oriental Institute, Tirupati,[2] by 'Tir.', the India Office Library, London,[3] by 'IO' and the Whish Collection of the Royal Asiatic Society, London,[4] by 'Whish'. Other public and private collections have been indicated by their full names. The *Catalogus Catalogorum of Sanskrit works and authors* (*CC*) by T. Aufrecht (Leipzig, 3 vols., 1891, 189', 1903; Rep., Wiesbaden, 1962) and the *New Catalogus Catalogorum* (*NCC*), (Madras University, 1949 ff.) are also referred to when necessary.

For facilitating general information and further study of individual works and authors, such details as the editions of the works, if available, and references to special articles on them are supplied towards the end of each entry. Besides these, their treatment in such important sources as': Ulloor, *Kerala Sahitya Charitram* (Ul.), (5 Vols., Trivandrum, 1953-57), Vatakkumkur, *Keraliya Samskrita Sahitya Charitram*, (Va.), (6 vols., Trivandrum-Trichur, 1938-65), and *Kerala Sahitya Charitram—Chacchayum Pūraṇavum*, (Ul. Sup.), (2 vols., Trichur, 1967-69), R. Narayana Panikkar, *Kerala Bhasha Sahitya Charitram*, (RNP), (7 vols., Trivandrum, nd.-1951), S.N. Sen, *Bibliography of Sanskrit works on Astronomy and Mathematics*, (Sen), (New Delhi, 1966) and K.K. Raja, 'Astronomy and Mathematics in Kerala : An account of the literature', (Raja), (*Adyar Library Bulletin*, 27 (1963) 118-67), has also been duly indicated. Other relevant pieces of information also find their due place here.

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1. *An alphabetical index of Skt. Mss. in the Govt. Or. Mss. Library*, Madras, 3 vols., 1938, 1940, 1942.

2. *An alphabetical index of Sanskrit, Telugu and Tamil Mss. in the S.V.Or. Res. Inst. Library*, Tirupati, 1956.

3. *A Cata. of Skt. and Pkt. Mss. in the India Office Library*, by J. Eggeling, 2 pts., London, 1887, 1896 ; and A.B. Keith, 2 pts., London, 1935.

4. *A Catal. of South Indian Skt. Mss., (especially those of the Whish Collection), in the Royal As. Soc., London*, by M. Winternitz, London, 1902.

BIBLIOGRAPHY OF AUTHORS AND WORKS

Aṁśakadaśanyanam (jā.), (Mal. prose), Anon. 30 gr.

Ms. L. 765-B.

Aṁśakaphalavicāra (jā.), Anon. (Skt.-Mal.), 125 gr.

Beg. guror api ca saṁvada iṣṭadaivatandanam /
kalivākyāni lagnam ca sūryādyeṣu grahasphuṭam //

Ms. TM. 119.

Akārādipraśna (pra.), (Mal.), Anon.

Beg. Vālmikirṣiproktam Rāmabhadrasvāmi-kathā. Śrī. Praśnam. Akārādi akṣaram, ı pustaka-lakṣaṇam kāṇum prakāram. grantham keṭṭikkoṇṭu kāryam vicāriccu etc.

Ms. CM. 2262.

Akṣarapraśna (pra.), (Mal.), Anon.

Ms. See *Ker. Mal.*, p. 1 ; Ad.

Do.—C (Mal.)

Ms. See *Ker. Mal.*, p. 1.

Agaṇita (kar.), (A.D. 1861) by Nalleppaḷḷi Subrahmaṇya Śāstri (A D. 1829-88), enunciating facile methods to read out positions of the planets for 1000 years.

Ref. : Ul. IV. 290, 292 ; Ul. Sup. II. 122-23 ; Va. IV. 607; RNP IV. 481-82.

Agaṇitagrahacāra or *Agaṇitapañcāṅga* (kar.), by Mādhava of Saṅgamagrāma, 2000 gr.

Beg. ādityapramukhān kheṭān vande lokaprakāśakān /
Agaṇitagrahacāre dṛśyate rāśinirṇayaḥ //1//
śakābdāt naralokonād rāghavair dhītsunā kujaḥ /
divylokonanīlāgrais tattvajñair bhājito budhaḥ //2//

Mss. 5955-A, C. 628, T. 280.

Aṅkaṇaśāstra, called also *Grahasamaya* or *Navagrahasamaya* (ja.), Anon., by a native of Vaikkam, couched in the form of a dialogue between Vyāghrapāda and some sages, in 4 chs., in 425 gr.

Beg. Vyāghrapādam aham vande śesāṁśena samudbhavam /
puṇḍarīkapureśasya padapaṅkajasaṁśrayam //
śṛṇvantu munayaḥ sarve durūham sarvadaivataiḥ /
grahāṇām samayam hyagre vakṣyāmi matimātrataḥ //

Ms. T. 206. **Ed.** *TSS*, No. 222, (Trivandrum, 1968). **Ref.** Ul. Sup. I. 221-22.

Acyuta I

—*Devakerala*, called also *Keralajyotiṣa*, *Candrakalānāḍī* and *Candranāḍī*.

Mss. Mad. D. 13776-79, R. 853 (a), 3322. **Ed.** Gov. Or. Mss. Lib., Madras, 3 vols., 1952-56. **Ref.** See above, p. 46, § 9.

Acyuta II : Acyuta Piṣāraṭi, (1550-1621), of Tṛkkaṇṭiyūr, pupil of Jyeṣṭhadeva and teacher of Nārāyaṇa Bhaṭṭatiri ; patronished by king Ravi Varmā of Veṭṭattunāḍ ; had a long line of teachers and pupils.

—*Uparāgakriyākrama*
—*Uparāgaviṁśati* (?)
—*Karaṇottama*
—C on *Karaṇottama*
—*Chāyāṣṭaka*
—*Jātakābharaṇa*
—*Rāśigolasphuṭānīti*
—C *on Veṇvāroha of Mādhava*
—*Sphuṭanirṇaya*
—C on *Sphuṭanirṇaya*
—*Horāsāroccaya*

Ref. See ~~above~~ Ker. Astron., pp. 12 ; 64-65, § 39 ; K. V. Sarma, Introductions to his edns. of *Rāśigola*° and *Veṇvāroha* ; S. V. Iyer, 'Acyuta Piṣāraṭi : His time and works', *JOR* 22 (1952-53) 40-46 ; Raja, 158-62 ; Ul. II. 319-26 ; Ul. Sup. I. 315 ; Va. II. 748-57.

Adhimāsanirṇaya, (astron.), Anon.

Beg. : meṣādyaikaikarāśisphuṭagatidinakṛtsaṅkramaikaikagarbhāḥ.

Ms. L. 1229-D (with C, 65 gr.).

Adhimāsanirṇaya (contd.)

Do—C (interspersed with Mal.), Anon.

Beg. : dvādaśamāsātmakatvena lokavedaprasiddhasya Cāndrasaṁvatsarasyāṅgabhūtānām lakṣaṇam āha—meṣādāvekaikasmin rāśau sphuṭagatyā.

Ms. : L. 1229-D.

Ayanacalanādigaṇita (astron.), (Mal.), by Śaṅkara of Mahiṣamaṇgalam.

Beg. tumpa tiṅkaḷoṭu gaṅga tanneyum etc.
candradhīlagnasaṁyuktam kollasaṅkhyayutam kramāt etc.

Ms. PM. 4026-A. **Men.** Ul. II. 272.

Aṣṭamaṅgalapraśna I (pra.), by Rudra II (?)

Beg. jayati bhagavān gajāsyo etc. // 1 //
satyajñānapradāyeṣṭa etc.

Ref. Ul. II. 117.

Aṣṭamaṅgalapraśna II (pra.), Anon., prose.

Beg. svasthacitto'pi vittasthaḥ samabhyarcya gaṇādhipam /
nijān gurūn devatāś ca sūryādiṁś ca navagrahān //
...anantaram viḷakkum gaṇapatiyum vaccu aṣṭamaṅgalavum vaccāl rāśicakram varappū /

Ms. 3556-C, 13494-K, CM. 565-A. **Ref.** Ul. III. 245.

Aṣṭamaṅgalapraśna III (pra.) Anon., (Mal. pr. and verse), 160 gr.

Beg. dūtasvabhāvam vacanam pravṛttim
sthalam ca tanṯe svaravum svavṛttim /

Ms. PM. 4029.

Aṣṭamijayantīnirṇaya (astron.), by Puṟayannūr Parameśvaran Nampūtiri (or Puradahanapura-dvija), A.D. 1810, 300 gr.

Ms. CM. 6-E. **Ref.** Ul. III. 476-82 ; Ul. Sup. I. 220-21.

Aṣṭakavarga (jā)

Ms. See *Ker.*, I. p. 43.

Do—C. (Mal.).

Ms. 6065-B.

Aṣṭakavargaprayoga (jā.), (Mal. prose), Anon.
Ms. 6065-B.

Aṣṭakavargaphalavicāra (jā.), (Mal.), prose, Anon., 225 gr.
Beg. ādityante aṣṭakavargattil paral pizhaiyāte etc.
Ms. C. 2338-C.

Aṣṭakavargopadeśam (jā.), (Mal. prose), Anon., 150 gr.
Ms. C. 565-C.

Aṣṭavargaprakāra (jā.), (Mal. prose), Anon.
Ms. 13294-Q.

Aṣṭavargaprakriyā (jā.), Anon., (Skt.-Mal.).
Beg. ... ...kanyāmakarau
śaraiś ca seṣāḥ svamānaguṇitāḥ syuḥ /
Ms. C. 962-B.

Aṣṭavargaprayoga (jā), Anon.
Beg. athāṣṭavargaprayoga ucyate. putro vāso dadhāṇaḥ syāt.
Ms. P. 894-B.

Ahargaṇādigaṇitam (?) I (kar.), (Mal.), Anon.
Beg. vākyasaṅkhyakaḷ vaccittu cenna tīyatī kūṭṭiyāl /
Ms. 10967-F (inc., 25 gr.).

Ahargaṇādigaṇitam (?) II, (kar.), (Mal.), Anon., in verse.
Ms. 13295-I (inc., 170 gr.).

Ahargaṇādigaṇitam (?) III, (kar.), (Mal.), in prose and verse.
Ms. 142 8-E (inc., 24 gr.).

Aharmānādigaṇitam (?) I, (kar.), Anon. Epoch : Kali 17,21,162, A.D. 1611.
Beg. 'prītāsyādyarasāyano'nadivasāa modāḍhya-putram tyajet.
Ms. 1005-C.

Do—C (Mal.), *Anon.*
Ms. 1005-C.

Aharmānādigaṇitam (?) II, (kar.), (Mal.), prose.
Beg. talkālacandran oṇṭākkuvān vākyam vaccu.
Ms. L. 765-H (inc., 140 gr.).

Aharmānādigaṇitam III (kar.), (Mal.), Anon.

Beg. purabhaktiḥ, sudhanedhyā, nṛpapaṭukapi, nityanindādhisūta-mūlāḍhyo meṣanaya ṛṇam yuṭaniyatapratāḥ (?) itu ubhe aharmānam.

Ms. PM. 4328-B.

Ācāradarśana (astrol.), Anon., by a pupil of Śaṅkara and Śrīvallabha.

Beg. ... vande Śaṅkaram Aṣṭamūrtijanakam Śrīvallabham vā gurum.

Ms. 1055-G.

Ācāradīpikā : Name of C on *Muhūrtāṣṭaka*.

Ācārasaṅgraha I (muh.), by Parameśvara of Vaṭaśreṇi.

Ms. : See *Ker.*, I. p. 54. Ref. Va. II. 686-87 ; III. 394-95 (where the work is said to be different).

Do.—C (Mal.), Anon.

Beg. Ācārasaṅgramākunna muhūrta-granthatte camappān tuṭaṅṅunna ācāryan.

Ms. 773-B.

Ācārasaṅgraha II (muh.), (Mal. prose), Anon., 2200 gr.

Mss. 5886-A, L. 1286.

Ānandaprakaśa, teacher of Nityaprakāśa Yati (au. of C on Horā)

Āyuḥpraśna (pra.), (Mal.), by Śaṅkara of Muktisthala.

Mss. 5109-A, 10582-C-2, C. 565-B.

Āyuḥpraśnādicintanam (pra.), (Mal. prose).

Ms. 13494-E.

[*Āyudhapraśna* (pra.), Anon.]

Do.—C (Mal.), Dūtalakṣaṇabhāṣāvyākhyā, 175 gr.

Beg. Āyudhapraśnasya dūtālakṣaṇa-bhāṣā likhyate / dūtan kizhakkoṭṭu ninnu iṭakkaikoṇṭāyudham piṭiccu.

Ms. C. 173-D.

Āyudhalakṣaṇam I (pra.), (Mal.), in verse, Anon., in 4 chs., 110 gr.

Beg. gurupādatte vandiccu kuaṟyekkoṇṭu bhāṣayāy /
arivāniha collunnen aham Āyudhalakṣaṇam //

Ms. See *Ker Mal.*, p. 16 ; P. 970-B ; PM. 4026-D.

Āyudhalakṣaṇam II (pra.), (Mal.), in verse, Anon., 62 gr.

Beg. ampiḷikkala cūṭunna tampurān mūttaputrane /
mumpil tozhutu kumpiṭṭen vanpōlum vāṇimāteyum //
aṟālum keṭṭinikkunnor āyudhathinnu lakṣaṇam /
arivān jñānadṛṣṭikku guruvin varam ekuka //

Ms. CM. 127-C.

Āyurdāyagaṇitam (?) (astrol.), (Mal.), Anon. in prose.

Beg. āyurdāyam varuttān jātakam varuttū.

Ms. L. 144-P, L. 1217-B.

Ārūḍhapraśna, by Śaṅkara : See *Sāmudrikasāra.*

[*Āryabhaṭīya* (tantra), *by Āryabhaṭa*]

Do.—C I, *Bhaṭaprakāśa* or °*prakāśikā* by Sūryadeva-yajvan, 2500 gr.

Mss. : See *Ker.*, I. p. 74 ; Ad., Mad.

Do.—C II, *Bhaṭadīpikā* by Parameśvara of Vaṭaśreṇi.

Mss. 10617, C. 1363-B ; Mad. Edn. H. Kern, Leiden, 1874 ; Udaya Narain Singh, Etawah, 1906.

Do.—C III, *Bhāṣya*, (for Gaṇita, Kālakriyā and Gola Sns. only, but not for Gītikā Sn.), by Nīlakaṇṭha Somayāji, 4000 gr.

Mss. : See *Ker.*, I. pp. 73-74, *NCC* II. 172. Edn. *TSS* 101, 111, 185.
Ref. : Ul. II. 119-20.

Do.—C IV, by Ghaṭīgopa, (Skt. com.).

Mss. 13305-A, T. 736.

Do.—C V, (Mal.) by Ghaṭīgopa, version I, 1200 gr.

Beg. of Gaṇitapāda : gaṇitapādattiṅkal muppattimūnnārya-kaḷekkoṇṭu yuktisiddhamāyirikkunna gaṇitatte colluvān tuṭaṅṅunna Āryabhaṭācāryan naṭette sūtram koṇṭu iṣṭa-devatānamaskāravum cikīrṣita-pratijñayum ceyyunnū—Brahma-śaśi etc.

[*Āryabhaṭīya*, C V, contd.]

Mss. 11014, L. 1334, T. 157-A, Mad. Mal. 215; ms. with K.V. Sarma. Ref. Ul. III.234-35.

Do.—C VI, (Mal.), by Ghaṭīgopa, version II, 1850 gr.

Beg. of Gaṇitapāda : Āryabhaṭacāryan Daśagīti-sūtram āyirikkunna prabandham koṇṭu atīndriyam āyirikkunna arthajātatte updeśicciṭṭu...śāstratte ārambhikkunnū—Brahmaśaśi etc.

Mss. C.2333-A, T. 157-B.

Do.—C VII, Anon.

Beg. vāgmajamahīkṣapam kṛjñāśukrasūryārasūriśanibhā (?) ... /
... ... vyākhyāyate'tha tattantram //

Ms. L. 1347-A (Inc., 2600 gr.).

Do.—C VIII, Anon.

Beg. athācāryāryabhaṭo Daśagītisūtram ārabhamāṇas tadvighnopaśāntaye bhagavate svayambhuve praṇāmam kṛtvā.

Ms. C. 1828.

Do.—C IX, Anon.

Beg. (of *Kālakriyā*): atha kālakriyāpādo vyākhyāyate. atra kālavibhāgam āha.

Mss. C. 2160-C (*Gaṇita* and *Gola* portions, 650 gr.); C. 2160-D (*Kālakriyā*, 450 gr.).

Do,—C X (Mal.), by Kṛṣṇa (?).

Beg. Āryabhaṭācāryan tantratte ārambhippān.

Ms. IO 6273 (all the four sections cm. : Rem. The label on the ms. reads '*Bhāṣāyām Kṛṣṇaṭīkā*' (?). The au. is diff. from Kṛṣṇadāsa, below, since the beg. of the two coms. differ.

Do.—C XI (Mal.), *Daśagītisūtram Bhāṣā*, by Kṛṣṇadāsa (Kṛṣṇan Āśān).

Ms. with K.V. Sarma.

Do.—C XII : See *Kakṣyāmaṇḍala* etc.

Azhvāñceri Tamprākkaḷ, (18th cent.), son of Nīlakaṇṭha's brother. While several mss. mention Āzh. as the author, a lone ms. (C. 2197-A, *Joytiśśāstrasaṅgraha*) mentions Kaypañceri Tamprākkaḷ instead, in the post-colophonic statement.

Azhvāñceri Tamprākkaḷ (contd.)

—*Jātakasārasaṅgraha*
—C (Mal.) on Do.
—*Jātakanītimārga.*
—C (Mal.) on Do.
—*Jyotiśśāstrasaṅgraha*
—C (Mal.) on Do.
—*Phalasārasamuccaya*
—C (Mal.) on Do.
—C (Mal.) on *Muhūrtapadavī* II
—*Saṅgrahasādhanakriyā*
—C (Mal.) on Do.

Ref. *Ker. Astro.*, pp. 71-72, § 57 ; Va. II. 123-27.

Iṭakkāṭṭu or Eṭakkāṭṭu Kukkaṇiyāl (17th cent.), pupil of Panakkāṭṭu Nampūtiri (au. of *Praśnamārga*).

—*Praśnarīti* II (Mal.).

Ref. *Ker. astron.*, p. 67, § 43 ; Ul. III. 235-37 ; Ul. Sup. I. 536 ; Va. III. 405.

Iṭakkāṭṭu Nampūtiri : *See under* Panakkāṭṭu Nampūtiri.

Iṭakramañceri Nampūtiri (17th cent.) ; of Peruñcellūr village ; pupil of Dāmodaran Nampūtiri of Maṅgalaśśeri house.

—*Bhadradīpagaṇita* (Mal.)
—*Bhūgolaññayam* (Mal.)

Ref. *Ker. Astro.*, p. 66, § 43 ; Ul. III. 232-34 : Ul. Sup. I. 534.

Īñcakkāzhvā Mādhava : See under Mādhava II.

Uccanīcādigaṇita (kar.), (Mal. prose).

Ms. 13194-B.

Uccādibalānayanam (kar.), (Mal. prose).

Ms. C. 2197-E.

Uḍugaṇaphalam (astrol.), Anon.

Ms. 3671-F.

Do.—C (Mal.), Anon.

Ms. 3671-F.

Uḍujātakodaya (jā.), Anon., (Ker. ?).

Beg. gaṇeśavāgdaivataviṣṇuśaṅkarān
inendubhaumajñagurūśanaśśanīn /

Uḍujātakodaya (contd.)

praṇamya pātoccagṛhāṁśca sadgaṇān
udāhariṣyāmy Uḍujātakodayam //

Mss. 1004-A, 10627-B, 13478-G, C. 1912-D, CM. 118-E, L. 690-D, L. 864-B, P. 876-I, P. 900-B.

Do.—C (Mal.), Anon.

Ms. 1004-A, 10627-B, CM. 118-E, P. 876-I, P. 900-B.

Udayadivākara (Ker. ?), (before, A.D. 1073, his epoch).

—C on an unidentified work of Jayadeva.

—C *Sundarī* on *Laghubhāskarīya* of Bhāskara I.

Ref. *Ker. Astro.* pp. 45-46, § 8; K. S. Shukla, 'Jayadeva, the mathematician', *Gaṇita*, (Lucknow), 5 (1954) 1-20.

Uparāga- : See also under *Grahaṇa-*.

Uparāgakriyākrama I (ecl.), by Acyuta Piṣāraṭi, A.D. 1592, in 4 chs., 175 gr.

Mss. See *Ker.*, I. p. 100. Ref. Ul. II. 323.

Do.—(Mal.), Anon., 425 gr.

Beg. gurūṇām caraṇambhoja etc. ; tithiye pratykṣamākkinṯa pramāṇam.

Mss. 404-B, 13389-D, C. 173-E, C. 531-B, C. 628-B, C. 541-C ; Mad. Mal. D. 216. Ref. Va. II. 682-83 (where it is wrongly described as the com. Nārāyaṇa's *Uparāga°*).

Do.—C (Mal.), *yukti* of certain sections, Anon.

Ms. With K.V. Sarma.

Uparāgakriyākrama II (ecl.), by Nārāyaṇa, in 5 chs., 300 gr. ; epoch A.D. 1561.

Mss. See *Ker.*, I. p. 100 ; Mad. Ref. Sen., p. 150 ; Ul. II. 121 ; Ul. Sup. I. 222 ; Va. II. 683.

Do.—C (Mal.), Anon. (300 gr.).

Ms. 770-B ; C. 531-B. Ref. Va. II. 683-84.

Uparāgakriyākrama III (ecl.), Anon., acc. to Nīlakaṇṭha Somayāji.

Beg. puṣpavantau namaskṛtya 'Nīlakaṇṭhokta-vartmanā' /
anyo vilikhyate kaścid Uparāgakriyākramaḥ //

Ms. 5862-C. Ref. Ul. Sup. I. 222-23.

Uparāgaviṁśati (ecl.), Anon., 60 gr., by Acyuta Piṣāraṭi (?)

Beg. puṇyaghnāt khaṇḍaśeṣād vitatha-bṛtalavādy ūnitaḥ khaṇḍaśeṣo.

Ms. Trippunithura Skt. Col. 1075. Edn. Rama Varma Maru Tampurān, *Śrī Ravi Varma Skt. Granthāvali*, (Trippunithura), 2 (1954) i-iii, 16 pp. Ref. Ascription of authorship, on the authority of Puliyoor Purushottaman Nampūtiri, Intro., to the *Sūryasiddhānta*, (Trivandrum, 1125 M.E.), p. x.

Do.—C (Mal.), Anon.

Beg. sūryagrahaṇam tān somagrahaṇam tān raṇṭālonnu.

Ms. Trippunithura Skt. Col. 1075. Edn. Rama Varma Maru Tampurān, with text, above.

Uparāgaṣṭaka (ecl.), Anon., 20 gr. Epoch : Kali 1703,790, A.D. 1563 :

Beg. 'nālosau gānasampad'-virahitadivasād.

Mss. 5817-A, C. 173-K.

Do.— C (Mal.), Anon.

Beg. anantaram Uparāgāṣṭakattinṭe bhāṣa camakkunna ācāryan sūryendukkaḷuṭe grahaṇatte ... nālosau.

Ms. C. 173-K.

Do.—C (Mal.), Anon., 175 gr.

Beg. anantaram sūryacandranmāruṭe grahaṇatte gaṇikkum prakāram collunnū—nālosau.

Ms. 5817-A.

Ṛtūtpattiphalam (astrol.), Anon., 30 gr.

Beg. sūrye vyādhisamṛ...somavāre patipriyam /
(bhaume) duḥkham avāpnoti budhe putrasamāgamam //

Ms. PM. 4077-E.

Ekaviṁśatipraśnakrama (arith.), Anon., (Mal.).

Beg. yaḥ sūryācandranetraḥ saridadhipasutātuṅgavakṣojalagnaiḥ

Ms. C. 541-D. Ref. Ul. III. 239-40.

Eñcuvaṭi (arith.) (Mal.), Anon.

Mss. See *Ker. Mal.*, pp. 23-24.

Etakkattu Kukkaniyāl : *See under* Iṭakkāṭṭu Kukkaṇiyāl.

Kakṣyādi-sphuṭa-gaṇitam (?) (kar.), (Mal.), Anon.

Ms. 151-D (inc., 70 gr.).

Kakṣyāpratimaṇḍalādi-śloka-yukti (on *Āryabhaṭīya*, Kāla., 17-21), (astron.) Anon., 135 gr.

Beg. atha sūryendvor madhyamāt sphuṭasya mandaphala-saṁskārād bhedo bhavati / kujādīnām etc. / tatra pratimaṇḍala-kalpanām sārdhābhyām āryābhyām kathayati—kakṣyāpratimaṇḍalagā etc. /

Mss. 8358-F ; IO. 6301 (*Golasāra* etc.), ff. 4b-11b.

Kaṭapayādi-saṅkhyāḥ (astron.).

Ms. Ad.

Do.—C, Anon.

Ms. Ad.

Kaṇakkatikāram (arith.), (Old Mal.), Anon.

Beg. paṇakkarinākamiṭṭum paṭarcaṭaiccivanu polum piṇakkarutāta celvam peruma cernnoḷiviḷaṅkum / Kaṇakkatikāram ennum kavita kaṭṭiyampuvānāy tuṇaikka nalkarimukatton tuyarkeṭattelintu vante //

Mss. See *Ker. Mal.*, p. 25. Ref. Ul. II.478. See also *Gaṇitanūl* to which this work seems to be related textually.

Do.—C (Mal.), Anon.

Mss. See *Ker. Mal.*, p. 25.

Kaṇakkucodyam (arith.), (Mal.), Anon., 15-16th cent.

Ref. Ul. II. 480.

Kaṇakkuśāstram I (arith.), (Mal.), by Kṛṣṇadāsa (Koccu-kṛṣṇan Āśān).

Ref. *Ker. astron.*, pp. 74-75, § 65 ; Ul. III.524.

Kaṇakkuśāstram II (arith.), (Mal.), Anon.

Ref. Ul. II. 479-80.

Kaṇakkusāram I (arith.), (Mal.), by Nīlakaṇṭha, 16-17th cent. (?) 1250 gr.

Kaṇakkusāram I (contd.)

Beg. eṇāṅkaśekharasutam gaṇanāthameṯṯam
vandiccu vaṇiye vaṇaṅṅi harim gurum ca /
nānāmunīn tozhutukoṇṭu Kaṇakkusāram
nere cameppatinu sāmpratam ārabhe ñān //

Mss. C. 2085-C ; CM. 630. **Ref.** Ul. II.478-79 ; Ul. Sup. I. 226-27 ; Va. IV. 276.

Do.—C (Mal.), by the au. himself.

Ref. Ul. II. 478-79.

Kaṇakkusāram II (arith.), (Mal. verse), Anon.

Ms. T. 874.

Do.—C (Mal.).

Ms. T. 874.

Kaṇṇaśśappaṇikkar

—C (Mal.), *Horāphalaratnāvali* on *Horā*, (apocryphal).

Karaṇam (?) (kar.), Anon., epoch A.D. 1734, 75 gr.

Beg. 'calanastutisaṅkhy'onam divasagaṇam dhīdaśodhanaiḥ kulīnāṅgaiḥ.

Ms. C. 2470-C.

Karaṇadarpaṇam (kar.), by a Bhāradvāja brāhman.

Beg. haripādāmbujam natvā Bhāradvājo dvijottamaḥ /
laghupūrvasphuṭopāyam vakṣye Karaṇadarpaṇam //

Mss. 597-D, 12367-D, E.

Do.—C (Mal.), Anon.

Mss. 597-D, 12367-D.

Do.—C (Mal.), Anon.

Beg. taveghnādi-khaṇḍaśeṣatte tāpam koṇṭu guṇiccu sudevanekkoṇṭu hariccāl varunna phalam rāśi.

Ms. 12367-E.

Karaṇapaddhati (kar.), by Putumana Somayāji of Śivapura (Trichur), 10 chs., 300 gr.

Mss. See *Ker.*, I. p. 120 ; Ad., Mad., *NCC* I. 174. **Edn.** *TSS*, No. 126 ; *Gov. Or. Ser., Madras*, No. 98, with two Mal. C-s.

Ref. Raja, 164 ; *Sen*, pp. 104-5 ; Ul. II.107-8 ; Va. I. 529-31.

Karaṇapaddhati (contd.)

Do—C I (Mal.), Anon.

Beg. Nūtanagṛha-Somasutā...... / aviṭe ācāryan prabandhatte camappān tuṭaṅṅunneṭattu...

Mss. See Intro. to Madras edn. ; Edn. See above.

Do—C II (Mal.), Anon.

Beg. Nūtanagṛha-Somasutā ... / Karaṇapaddhatiyākunna granthatte camappān tuṭaṅṅunna ācāryan...

Mss. See Intro. to Madras edn. Edn. See above. Ref. Ul. III. 238-39.

Do—C III (Mal.), *Śakābdasaṁskārakriyā*, on verses I. 12-13, Anon., 100 gr.

Ms. 5820-C. Edn. App. pp., 307-11, to the Madras edn., above.

Karaṇasāra (kar.) by (?Śaṅkara Vāriyar), pupil of Nīlakaṇṭha Somayāji and Dāmodara ; 4 chs., 135 gr. Epoch : *anūnajñānasādhya*, Kali day 17,00,000, A.D. 1553.

Beg. ābhātyadvayadantādhyam... (1); jayanti mānsāmbhoja... (2);
Śrī-Nīlakaṇṭham ācāryam Śrīmad Dāmodaram gurum /
praṇamya likhyate kiñcid gaṇitam sulaghukriyam //

Do—C (Mal.), *Kriyākrama* by Śaṅkara Vāriyar.

Mss. C. 8-B, C. 173-J. Ref. Ul. II. 474.

Karaṇāmṛta (kar.), by Citrabhānu, A.D. 1550, 4 chs., 120 gr.

Mss. C. 1380 A, B ; T. 734 ; *NCC* I. 176.

Do.—C I Anon., 900 gr.

Beg. śivam dadyācchivo mahyam etc. // tatrādau tāvad Ācāryaḥ Karaṇāmṛtam nāma prakaraṇam cikīrṣuḥ....

Mss. C. 1380-B, T. 734.

Do.—C II, Anon., 1000 gr.

Beg. śivam dadyāc chivo mahyam etc. /
vāgīśvarīm praṇamyāham gurumścārkādikān grahān /
prārabhe Citrabhānūktam vyākhyātūm Karaṇāmṛtam //

Ms. C. 1380-B.

Karaṇottama (kar.), by Acyuta Piṣāraṭi, 5 chs., 150 gr.

Mss. See *Ker.*, I. p. 120 ; Mad. ; *NCC* I. 176. Ed. *TSS*, No. 213.

Ref. Ul. II. 323-24.

Do.—C I by the au. himself, 400 gr.

Beg. atha iṣṭadevatānamaskārapūrvakam cikīrṣitam pratijānāti—praṇipatya etc.

Mss. See *Ker.*, I, p. 120 ; Mad. ; *NCC* I. 176. Edn. *TSS*, No. 213.

Do—C II (Mal.), Anon., by a Kerala brāhman.

Beg. anantaram Karaṇottamattinte bhāṣayuṇṭākkuvān tuṭaṅṅunnū.

End : Acyutan tān camaccuḷḷa Karaṇottamakasya tu /
bhāṣāvyākhyānam uṇṭakkī Keralīyo dvijottamaḥ //

Ms. with K.V. Sarma.

Karmadīpikā I : Name of C by Parameśvara I on the the *Mahābhāskarīya* of Bhāskara I.

Karmadīpikā II : Name of C by Nārāyaṇa I on *Līlāvatī* of Bhāskara II.

Kalidinādigaṇitam (?) (kar.) (Mal.), Anon., 140 gr.

Beg. dhījagnnūpuram koṇṭu kalyabdattep perukkiyāl /
tatsamena hariccuḷḷa phalaṅṅal divasaṅṅaḷām //

Ms. 11064-A.

Kālacakradaśānayanam (jā,), Mal. prose, Anon., 20 gr.

Ms. 3631-D.

Kālacakradaśānirṇaya (astrol.). Ms. L. 336-F (inc.)

Do.—C (Mal.). Ms. L. 336-F (inc.).

Kāladīpa (astrol.), by Vasudevasvāmi.

Beg. vande'mbujaprabhākṣam mābhūbhyām cārutaram yutam /
lasannāge'śucan saktam amlānam kṣaravarjitam //

Mss. L. 1379-C, D ; Mad. R. 5158 (b). Ref. Va. III. 392-94.

Do.—C. by Śyāmalavāraṇarāja, a prince.

Mss. L. 1379-C ; Mad. R. 5158 (b). Ref. Va. III. 392-93.

Kāladīpaka I (muh.), by Śaṅkaran of Nampūtiri of Mahiṣamaṅgalam. I : shorter version (Mal. title : *Ceṟiya Kāladīpakam*).

Mss. See *Ker. Mal.*, pp. 29-31.

Do.—C I (Mal.), Anon. Mss. 151-C, 935-D, 19842-B.

Do.—C II (Mal.), Anon., 850 gr. Ms. 3630-C.

Kāladīpaka II (muh.), by Śaṅkaran of Nampūtiri of Mahiṣamaṅgalam : II. Longer version (Mal. title : *Valiya Kāladīpakam*).

Mss. See *Ker. Mal.*, pp. 31-32. **Edn.** With auto-com., See below.

Do.—C *Bālaśaṅkaram* (Mal.), by the author himself.

Mss. See *Ker. Mal.*, p. 32. **Edn.** *Sri Vanchi Setu Lakshmi Series*, Nos. 6, 13, 15, Trivandrum.

Kāladīpikā (astrol.), Anon.

Ms. Vaṭavarkkoṭṭu Mana, Venkitangu, List I, 14.

Do.—C (Mal.), Anon. Ms. Vaṭavarkkoṭṭu Mana, Venkitangu, List I, 14.

Kālaprakāśikā (astrol.), (Mal.), Anon., pupil of Pūrṇaprabodha ; 2 pts., 340 gr.

Beg. arkabimbamakame vasiccukoṇṭ ittrilokamatil ātmatejasā /
satkriyādyakhilakālabodhadam cakrapāṇiye vaṇaṅṅiṭunnu ñān //
Pūrṇaprabodha-mukhasadguṇa-madgurūṇām
pūrṇaprasāda-paramāśrayavaibhavena / ... ... /
bālaprabodhamatināy adhunā Muhūrta-
Kālaprakāśika curukkiyatāy camappān //

Mss. 12686-E ; Pāliyam List, 621.

Kālārpaṇam : See *Laghukālārpaṇam*.

Kujādipañcagraha-mahāvākya or *Samudravākya* (kar.), (Ker. ?) 2075 mnemonic sentences of the cyclic tables of planets, Anon. 750 gr.

Mss. See Intro., pp. v-vi of *Vākyakaraṇa*, ed. T. S. Kuppanna Sastri and K.V. Sarma, K. S. R. Inst., Madras, 1962 ; L. 893-A, T. 510 ; **Edn.** *Ibid.*, App. III, pp. 135-249. **Ref.** For their application in the computation of true planets, see *ibid.*, Intro., pp. xvii-xx ; 258-60.

Kujādisphuṭagaṇitam (kar.), (Mal.). Ms. 151-D.

Kujādisphuṭasaṁskāraḥ (kar.), Anon. Ms. 14039-A.

Do.—C (Mal.), Anon. Ms. 14039-A.

Kuṭṭākārādigaṇita (math.), Anon., 350 gr.

Beg. atha kuṭṭākārādikriyām āha.

Ms. 14076-D, L. 1337-B.

Kumāra-gaṇaka, (14th-15th cent.), a protege of Devaśarmā, br. of Govinda, possibly of the royal brāhman family of Ampalappuzha.

—*Raṇadīpikā.*

Ref. *Ker. Astron.*, p. 50, § 20 ; Ul. II. 112-13 ; Va. II. 725-29.

Kṛṣicakraṅṅal (nat. astrol.), (Mal.), Anon.

Ms. 10856-G (with diagrams).

Kṛṣṇa I or **Kṛṣṇācārya**, (*c*. 1200), an early and highly popular author q. by Govinda Bhaṭṭa (1237-95).

—*Cintājñāna* or *Kṛṣṇīya*

—C *Kṛṣṇīya* on *Horā*

Ref. *Ker. Astron.*, p. 47, § 12 ; *Ul.* I. 169-70.

Kṛṣṇa II, (diff. from Kṛṣṇadāsa, below).

– C (Mal.) on *Āryabhaṭīya*

Ref. *Ker. Astron*, p. 70, § 53.

Kṛṣṇadāsa (Kṛṣṇan Āśān or Koccu-Kṛṣṇan Āśān), (1756-1812), of Neṭumpayil house near Tiruvalla.

—*Kaṇakkuśāstra* (Mal.)

—*Pañcabodha VIII* (Mal.)

- C (Mal.), *Daśagītisūtram-bhāṣā* on *Āryabhaṭīya, Gītikāpāda.*

—C (Mal.), *Bhaṣājātakapaddhati* on the *Jātakapaddhati* of Parameśvara

Ref. *Ker. Astron.*, p. 74-75, § 65 : Ul. III.519-27 ; Ul. Sup. 647-48 ; Intro. to the edn. of *Bhāṣā-jātakapaddhati.*

Kṛṣṇan Āśān : *See* Kṛṣṇadāsa.

Kṛṣṇa-śiṣya, (c. 1200).

—*Praśnaphalaprāptikālanirṇaya*

—C on *Horā*

Ref. *Ker. Astron.*, pp. 47-48, § 13.

Kṛṣṇīya or *Cintājñāna* (astrol.) : See *Cintājñāna.*

Keralajyotiṣa (astrol.), by Acyuta I : See under *Devakerala.*

Kerala-dvādaśabhāvaphalam I (astrol.), Anon., (Ker. ?), in verse.

Beg. lagnādhipo vā jīvo vā śukro vā yadi kendragaḥ /
tasya putrasya dīrghāyur dhanavān rājavallabhaḥ //

Ms. 4853-B (inc., only 10 of the 11 sns.).

Kerala-dvādaśabhāvaphalam II (astrol.), (Ker.?), Anon., in prose, apparently a prose redaction of the above work. **Ms.** 4854.

Kerala-dvādaśabhāvavākyāni (astrol.), (Ker. ?) by Vararuci, 12 chs., in prose, 150 gr.

Beg. Kerala-dvādaśabhāvavākyāni likhyante. dehasthānādhipaḥ ṣaṣṭāṣṭama-vyaya-sthānādhipaś cet dehasaukhyam bhavati.

Col. Iti Keralīya-Vararucivākye ... ... dvādaśodhyāyaḥ. Kerala-Vararuci-prokta-Bhāvaphalam.

Ms. 4853-A. **Ref.** Ul. Sup. I. 228.

Kerala-Nāḍīgrantha (astrol.), by Keralācārya. **Men.** Va. IV.255.

Keralanirṇaya or *Jātakarahasya* : See under *Vararuci-kerala.*

Kerala-Praśnasāra (pra.) by Keralācārya.

Men. Va. IV. 255.

Kerala-rahasya by Acyuta I : See *Devakerala.*

Kerala-saṁhitā (nat. astrol.), by Keralācārya.

Men. Va. IV. 255.

Keralācārya, (12 cent. ?), of the Kāśyapa gotra, native of Trichur ; said to be an authority on Jyotiṣa and Āyurveda and minister of the Kerala king Rāma Varmā (?). Or, is he only an apocryphal author ?

Keralācārya (cont.)

—*Kerala-nāḍīgrantha*
—*Kerala-Praśnsāra*
—*Keralīya-Praśnamārga*
—*Keralasaṁhitā*

Ref. *Ker. Astron.*, pp. 46-47, § 10 ; Ul. I.164 ; Va. IV. 255-56.

Keralīya-dvija, real name not known.

—C (Mal.) on *Karaṇottama* of Acyuta Piṣāraṭi.

Ref. *Ker. Astron.*, p. 70, § 54

Keralīya-Praśnamārga (pra.), by Keralācārya.

Men. Va. IV. 255.

Koccu-Kṛṣṇan Āśān : *See* Kṛṣṇadāsa.

Kriyākramakarī, names of two commentaries, both by Nārāyaṇa, on the *Līlāvatī* of Bhāskara II.

Kriyasaṅgraha I (kar.), Anon., in six sns., on the computation of *śrāddha*, *sthālīpāka*, *kalyabdādi*, *cakrārtha*, *chāyā* and *grahaṇa*, 300 gr.

Beg. śraddhāpurassaram natvā grahān api gaṇeśvaram /
śrāddhacandrādigaṇana-Kriyāsaṅgraha ucyate //

Mss. C. 621-D, C. 2470-D. **Ref.** Va. II. 685-86.

Do.—C I, *Kriyāsaṅgrahakriyāmārga*, Anon., 1650 gr.

Beg. gurudhyānena sambandhahṛdayāmburuham mayā /
Kriyāsaṅgraha-samproktam kriyāmārgam vilikhyate //

Mss. 1093, 12804-B, T. 139, T. 140-A.

Do—C II (Mal.), Anon. **Ms.** 844-D.

Kriyāsaṅgraha (?) II (kar.), (Mal.), Anon.

Beg. candrārkayoge nālañcu patinonniha pattapi /
rāśi vannāl annu cintyam lāṭavaidhṛtadoṣakau //

Ms. T. 140-B (inc., 500 gr.).

[*Kṣudrapraśna* (pra.)]

—C (Mal.), Anon., 70 gr. **Ms.** 10512-C-3.

Khaṇḍajyādi (kar.), miscellaneous sine tables etc., Anon.

Ms. L. 1242-B (120 gr.).

Khaṇḍadhruvādyānayanam (kar.).

Ms. C. 2197-K, L. 1221-C (70 gr.),

Khaṇḍadhruvānayanam I (?) (kar.), (Mal.), Anon.

Beg. ini dṛkkile khaṇḍavam dhruvavum uṇṭākkum prakāratte collunnū.

Ms L. 1221-C-1 (18 gr.)

Khaṇḍadhruvānayanam II (?) (kar.), (Mal.), Anon., 45 gr.

Beg. iṣṭadivasatte kali vaccu amitayavotsu' a ennu vāṅṅi ...

Ms. C. 2197.

Gaṇanakriyādi (?) (kar.), (Mal. verse), Anon. Ms. CM 530-D.

Gaṇita : See also under *Grahagaṇita, Grahaṇagaṇita, Candracchāyāgaṇita, Chāyāgaṇita, Vyatīpātādigaṇita* etc.

Gaṇita I (?) (kar.), Anon., Misc. calculations and tables.

Ms. 333-B (200 gr.).

Gaṇita II (?) (kar.), misc. calculations and tables. Ms. 1170-B (200 gr.)

Gaṇitakrama, (kar.), Anon. Mss. Cranganore Palace, 65, 177.

Gaṇitakriyā (?) (kar.), Anon., misc. computations; epoch A.D. 1527.

Beg. 'dhīpatirnaḷatuly'onam śivadūtāhatam dinam.

Ms. C. 531-C (inc., with C, 500 gr.). C. 1954-I (inc., 210 gr.).

Rem. Some of the procedures have been adapted from the *Veṇvāroha* of Mādhava.

Do.—C (Mal.), Anon. Ms. C. 531-C (inc., 500 gr. with text).

Gaṇitagrantha I (kar.), by Panakkāṭ or Iṭakkāṭ Nampūtiri, A.D. 1671. Mss. Not identified. Ref. Ul. III. 88 ; Va. III. 401;

Gaṇitagrantha II (kar.), by Putumana Somayāji (?)

Beg. madīyahṛdayākāśe cidānandamayo guruḥ /
udetu satatam samyag ajñānatimirāruṇaḥ //
pātonāt svamṛdusphuṭād bhujagaṇaḥ kṣiptāntyayā tāḍitaḥ

Ms. Mad. R. 5151 (c).

Gaṇitagrantha II—C. Anon.

End : asyārthaḥ—kujasya dve kale madhyama-bimba-kalāmānam / budhasya tisraḥ kalāḥ / guros sārdhās tisraḥ / śukrasya catasraḥ kalāḥ / śaneḥ dve kale, daśa vikalāś ca hi (?) / tā vyāsārdhahatāḥ svacaturdha-karṇahṛtād bhaumādīnām sphuṭabimba-kalāmanāni syuḥ //

Ms. Mad. R. 5151 (c).

Gaṇitadarpaṇa, (? *Siddhāntadarpaṇa*) (siddhānta), by Nīlakaṇṭha Somayāji, 45 gr.

Ms *List of mss. collected by the Curator for the Pub. of Skt. mss.*, Trivandrum, App. to the *Annual Adm. Rep of the Travancore State*, M.E. 1104, no. 75.

Gaṇitanūl (arith.), (Old Mal.), Anon.

Beg. Maṇi nī keḷ pūmitoyavāyuvākāśam ennum
maṇitikeḷanattamāti arimporuḷakinnu /
tuṇayillātoruvan tanne tozhutu ñān
talanīrkkoṇṭa Gaṇitanūl atinecconnān //

Ms. CM. 566-A. **Rem.** This work is related to *Kaṇakkatikāram*, textually.

Gaṇitanyāyasaṅgraha : See *Yūktibhāṣā*.

Gaṇitam Bhāṣā I (astron.), (Mal.), Anon., 500 gr.

Beg. Gīrnaḥ śreyaḥ ... ...

End divasāgararatnāni deśāntaraviliptikāḥ /
ādityacandratuṅgānām vikalādi puroktavat //
Gaṇitabhāsā samāptā.

Ms. 935-C.

Gaṇitam Bhāṣā II (astrol.), (Mal.), Anon.

Beg. sāyanārkaneyeṇṇunna prakāram atha collinen /
antikkekku gaṇikkeṇam śrāddham saṁśayamākilo //

Ms. 12367-C.

Do. III : Mss. 1416-E (verse, inc., 450 gr.)

Do. IV : „ 5076-B (mixed, inc., 4800 gr.)

Do. V : „ 5109-B (prose, inc., 80 gr.)

Do. VI : „ 5815 (mixed, inc., 400 gr.)

Do. VII : „ 5820-B (mixed, inc., 240 gr.)

Gaṇitam Bhāṣā (contd)

Do. VIII : „ 12367-C (mixed, inc, 225 gr.)
Do. IX : „ T. 149 (mixed, inc., 1C00 gr.).
Do. X : „ T. 251-A (mixed, inc., 230 gr.)
Do. XI : „ T. 897 (mixed, inc., 700 gr.)
Do. XII : „ PM. 4345-B (mixed, inc., 19 gr.)
On the above See *Ker. Mal.*, pp. 47-48.

Do. XII (kar.), Anon. ; epoch : Kali 16,89,131, A.D. 1523.

Beg. 'paulastyādhirhitāy'onita-kalidivase prastragorājyabhakte etc. ; dhanyā ramā sā etc. ; koḷambam taraḷāṅgāḍhyam etc.

Ms. PM. 4043-B.

Gaṇita-yuktayaḥ (astron. rationale), by a Bhāradvāja brāhman.

Beg. viditvāryabhaṭaprokta-golatattvena kenacit /
Bhāradvājena tanyante kāścid gaṇitayuktayaḥ //

Mss. 755 ; Mad. Mal. D 339, pp. 83-89 ; Crangannore Palace, no. 242.

Gaṇita-yukti (math.-astron. rationale).

Beg. vande gaṇḍataṭasravanmadadhuni etc.

gurupādāmbujam natvā dhyātvā sāmbaśivam mayā /
likhyate gaṇitam kṛtsnam grahagatyupayogi yat //

Ms. Mad. R. 4382. **Ref.** For Mal. version, see *Yuktibhāṣā* ; Ul. III. 440 ; Ul. Sup. I. 616.

Gaṇitavākyāni (kar.), Anon. **Ms.** L. 893-A.

Gaṇitasaṅgraha : Alt. title for Pt. I of *Jyotiśśāstrasaṅgraha* of Azhvāñceri Tamprākkaḷ.

Gaṇitasāra I (kar.), (Mal.), Anon.

End. of Ch. I : tekkum kollattu vāṇijyā agnīndhram tiruvallabhe /
...tatra tatra tu keṭṭiṭṭu pūrvācāryoktam ācaret //

Ms. PM. 4158-A.

Gaṇitasāra II or *Pañcabodha-Gaṇitasāra* (kar.), (Mal.), by Śaṅkaran Nampūtiri of Mahiṣamaṅgalam, in 8 chs., 1550 gr.

Mss. See *Ker. Mal.*, p. 48. **Men.** Ul. II. 472.

Gaṇitasūcika, by Govinda Bhaṭṭa (?), in 6 chs.

Ms. Q by Va., but said to be missing ; possibly a fictitious work.

Men. Va. I. 530, III. 390.

Garbhalakṣaṇam (astrol.), (Skt.-Mal.), Anon.

Beg. ini ippoḷ garbham uṇṭo ennaṟivān collunnu. lagnārūḍhaṅṅaḷil tān etc.

Ms. C. 565-E.

Gīrnaḥ śreyādi-Candavākyāni or *Vararuci-vākyam* (Moon mnemonic table) by Vararuci I.

Mss. See *Ker.* I. 212-14 (*Candravākyam*). **Edn.** *Candarvākyas* of Vararuci, Adyar, 1948 ; App. II, pp. 125-34 to the edn. of *Vākyakaraṇa*, Madras, 1962.

Guṇakārādipramāṇa (kar.), (Mal., prose), Anon. **Ms.** 4124-B.

Gurumandādijyāḥ (kar.), (Mal). **Ms.** 13445-B.

Goda Varmā. **Ref.** *Ker. Astron.*, p. 78, § 75.

Goladīpikā I (spherics), by Parameśvara of Vaṭaśreṇi, A.D. 1443, 4 chs., 300 gr.

Beg. vande kiśoram pārvatyā aṅkasaṁstham gajānanam /
stanyapānaratam kalpadrumasyādho vināyakam //

Mss. See Intro., p. 9, to edn. ; Mad. **Ed.** with auto-com. and Tr., by K.V. Sarma, Adyar Library, Madras, 1957.

Do.—C *Vivṛti* by the author himself. **Mss.** See Intro , p. 10, to edn. ; Mad. **Edn.** K.V. Sarma, Adyar Library, Madras, 1957.

Ref. Va. IV. 223-24.

Goladīpikā II (spherics), by Parameśvara of Vaṭaśreṇi, 302 āryā verses in one sequence.

Beg. vighneśvaram vāgdevīm gurūn dineśādikān grahān /
vakṣye bhūgolam asmai kṣoṇimānādikam ca laghumataye //

Mss. See Intro. to edn. **Edn.** *TSS* 49. **Ref.** Ul. II. 322-23, where it is wrongly described as the work of Acyuta Piṣāraṭi.

Goladīpikā III, (spherics), by Parameśvara of Vaṭaśreṇi. A highly expanded version of *Goladīpikā* II. Ms. IO 6297.

Golavāda (spherics) by Mādhava of Saṅgamagrāma.

Ms. Elaṅkunnappuzha Kovilakam List, 20. Ref. On the loss of this ms., see note by K. V. Sarma, *Mathrubhumi Weekly*, (Mal., Kozhikode), 17.6.1956, p. 4.

Golasaṁsthānam (spherics), Mal. verse, Anon.

Beg. ādityāstamayodayaṅṅaḷil vidhau śṛṅgonnatikkarkkanum / candran pāmpoṭu kālalagnavum uṭan vaccittu rāśitrayam //

Ms. PM. 4186-B (100 gr.).

Golasāra (spherics), by Nīlakaṇṭha Somayāji, in 3 sns., 56 verses.

Mss. See Intro., pp. viii-xi to edn.; Mad. Edn. and Tr. by K.V. Sarma, V.V.R.Inst, Hoshiarpur, 1970.

[*Golādhyāya* (astron.), of Bhāskara II]

—C by Vidvān Iḷaya Tampurān of Koṭuṅṅallūr.

Men. Ul. IV. 34; Va. IV. 318; RNP IV. 400.

Do.—C *Jyotiṣaprakāśanam*, by Rājarāja Varmā Koyittampurān.

Ms. C. 719.

Govindakṛti (astron.), by Govindasvāmin.

Rem. Known through qns. in the works of Śaṅkaranārāyaṇa (C on *Laghubhāskarīya*, under II.3, IV. 9, VIII. 18), Nilakaṇṭha Somayāji (*Āryabhaṭīya-bhāṣya*, *Gaṇita*. 4, 33) and Nārāyaṇa (C *Kriyākramakarī* on *Līlāvatī*, I. *Trairāśika*, 3 etc.

Govinda Bhaṭṭa

— *Gaṇitasūcikā*.

Men. Va. I. 530, III. 390.

Govinda Bhaṭṭatiri of Talakkuḷam, (1237-95).

—C *Daśādhyāyī* on *Horā*

—*Muhūrtapadavī* I

—*Muhūrtaratna*

Ref. *Ker. Astron*, p. 49, § 17; Raja, 132-33; Ul. I.167-69; Va. I. 353-59, II. 499-500; Koṭṭārattil Śaṅkuṇṇi, *Aitihyamālā*, Pt. I, (6th edn., Trichur, 1961), pp. 99-108.

Govindapaddhati (astrol.), by Govindasvāmin.

Ref. by Nīlakaṇṭha Somayāji in his *Grahaṇādigrantha*, ms., p. 44 ; Raja, 127.

Govinda Piṣāraṭi of Kailāsapuram house, in Vaikkom, teacher of the anon. com. on Parameśvara's *Jātakapaddhati*.

Ref. *Ker. Astron.*, p. 70, § 55.

Govindamaṅgalam Nampi, (15th-16th cent.), teacher of Mādhava of Īñcakkāzhvā (au. of *Praśnasāra* I).

Govinda-śiṣya, real name not known ; native of Vaikkom.
— C on the *Jātakappadhati* of Parameśvara I.

Ref. Ul. III. 89-90 ; Ul. Sup. I. 464 ; Va. III. 382-83.

Govindasvāmin, (*c.* 800-850), teacher of Śaṅkaranārāyaṇa who was court-astronomer of King Ravi Varmā at Mahodayapuram, the then capital of Kerala.
—*Govindakṛti*
—*Govindapaddhati*
—C *Prakaṭārtha* or *Sampradāyapradīpikā* on *Parāśarahorā*
—C *Bhāṣya* on the *Mahābhāskarīya* of Bhāskara I

Ref. *Ker. Astron.*, pp. 14-15 ; 44-45, § 6 ; T.S.K. Sastri, Intro., pp. xlvi-l of his edn. of the *Mahābhāskarīya*, (Madras, 1957) ; Raja, 127-28 ; Ul. II. 96-97.

Gauliśāstram (nat. astrol.), (Mal.), by Rāma Vāriyar of Kaikkulangara. **Ref.** *Ker. Astron.*, p. 80, § 81.

Grahakarmasaṅgraha (astron.), Anon., 60 gr.

Beg. golam jyotirmayam natvā granthair pūrvakṛtair api /
karomi bālabodhārtham Saṅgraham Grahakarmaṇām //

Mss. 1025, 1050.

Do.—C, Anon., 300 gr. **Ms.** 1050.

Grahagaṇitam (?) I (kar.), (Mal. verse), Anon. **Ms.** 13034 (80 gr.)

Do. II : **Ms.** 13057-B (verse, 200 gr.)
Do. III : „ 13073-C (with Mal. C, 75 gr.)
Do. IV : „ 13136-D (verse, 40 gr.)
Do. V : „ 13149-J (verse, 95 gr.)
Do. VI : „ 13194-C (verse, 350 gr.)
Do. VII : „ 13294-V (mixed, 100 gr.)
Do. VIII : „ C. 555-A (verse, 500 gr.)
Do. IX : „ L. 336-A (verse, 500 gr.)

Grahacakralekhanavidhi (astron), Anon. **Ms.** 12999-S.

Grahacāra I (kar.), Tables for the day-to-day reading of the planets.

Ms. 1100. **Rem.** For the years A D. 1845-55.

Grahacāra II (kar.), Tables for the day-to-day reading of the planets.

Ms. P. 873 (inc., 2000 gr.).

Grahacāra : See also *Agaṇita-grahacāra*, *Pañcāṅga.*

Grahacāranibandhanam (kar.), by Haridatta ; the source-book of the Parahita system of Kerala, 3 sns., 150 gr.

Mss. See Intro., pp. x-xii, to the edn. of the work. **Edn.** K.V. Sarma, K.S.R. Institute, Madras, 1954.

Grahacāranibandhana-saṅgraha (kar.), Anon. **Ms.** See Intro., p. xii, to the edn. above. **Edn.** K. V. Sarma, as App. to the edn. above.

Grahacāraphalam (astrol.), Anon., being a summary of the *Gocārādhyāya* of the *Bṛhatsaṁhitā*.

Beg. Varāhamihireṇoktam Saṁhitāyām savistaram /
Grahacāraphalam yat tat saṅkṣipyātha mayocyate //
āyāso vibhavakṣayo'dhvagamanam ...

Mss. C. 2259 C, D.

Do.—C I (Mal), Anon,

Beg. janmattil sūryan— āyāsam, vibhavakṣayam, sañcāram. rogapīḍā.

Ms. C. 2259-C.

Do.—C II (Mal.), Anon. **Ms.** C. 2259-D.

Grahacāraphalādinirūpaṇam (astrol.), Anon. **Ms.** 865-A.

Do.—C (Mal.), Anon. **Ms.** 865-A.

Grahaṇa (ecl.), (Mal.) Readings of a solar eclipse in A.D. 1687.

Beg (8)63-ām āṇṭu tulāmāsam 24-ām tiyati sūryagrahaṇam. 'dānto naḷo vai sevyaḥ' ka(li).

Ms. CM. 595-I (40 gr.).

Grahaṇagaṇita I (ecl.), by Putumana Somayāji (?), in 16 verses.

Beg. madīyahṛdayākāśe cidānandamayo guruḥ /
udetu satatam samyag ajñānatimirāruṇaḥ // 1 //

sūryendvor grahaṇam sphuṭam gaṇayitum ... (2) ; sūryendū sagatī tamaś ca... (3).

Ms. With K.V. Sarma. This work incorporates into it *Grahaṇāṣṭaka* II. The two works seem to be by the same author, who might be Putumana Somayāji, as inferred on the basis of his characteristic initial verse *madīyahṛdayākāśe* etc.

Do.—C (Mal.), Anon.

Beg. madīyahṛdayākāśa iti. iprakāram guruvine prārthicciṭṭu sūryendukkaḷuṭe grahaṇatte arivān collunnū...

Ms. With K.V. Sarma.

Grahaṇagaṇita II (ecl.), Anon.

Beg. mārtāṇḍasyoparāgam... (1) ; kṛtvā liptāsu bhedam... (2)

Ms. With K.V. Sarma.

Grahaṇagaṇita III (ecl.), Anon. ; an improvement on Acyuta Piṣāraṭi's *Uparāgakriyākrama* in 14 verses.

Beg. sūryendvor auparāgam gaṇanam abhinavam procyate 'tr-Ācyutoktāt / parvānte'rkendutuṅgād... (1).

Ms. With K.V. Sarma.

Do.—C (Mal.), Anon.

Beg. sūryendvor iti. ādityanṟeyum candranṟeyum grahaṇatte sambandhiccuḷḷa gaṇanam apūrvam āyiṭṭu onnu collappeṭunnū.

Ms. With K.V. Sarma.

Grahaṇagaṇita (?) IV (ecl.), Anon., in 12 verses.

Beg. parvānte punar ūhite... (1) ; vyarkendvor bhuja... (2).

Col. iti Grahaṇakhaṇḍaḥ.

Ms. With K.V. Sarma.

Grahaṇagaṇita V (ecl.), Anon., in 10 verses.

Beg. pātārkaikya ... (1) ; vyarkendvor bhuja ... (2) ; ākṣam sundara ... (3).

Ms. With K.V. Sarma.

Grahaṇagaṇita VI (ecl.), Anon., 280 gr. ; epoch, Kali 1629048, A.D. 13:9.

Beg. 'daivajñādhiṣṭhitārko'na-dyugaṇam sthānigokharaiḥ ...

Ms. L. 1329-B.

Grahaṇagaṇita VII (ecl.), Anon. Au. same as for *Grahaṇopadeśa*, below.

Beg. māyāparvantanāḍīvivararahitanighnāḥ dharānāgabhaktāḥ...

Mss. 1005-E, 12367-B.

Do.—C (Mal.), Anon.

Beg. itin poruḷ. grahaṇadivasattinnāḷe udayattinnu...

Mss. 1005-E, 12367-B.

Grahaṇagaṇita VIII (ecl.), (Mal.), Anon.

Beg. kalyabdād giriśātmabhūvininatād ā candravāroditāt.

Ms. 1187-A (cata. *Grahaṇādigaṇita*) ; Mad. D. 339 (pp. 11 ff.)

Do.—C (Mal.), Anon. Ms. 1187-A ; Mad. Mal. D. 339 (pp. 11 ff.)

Grahaṇagaṇita IX (ecl.), Anon.

Ms. 13294-D.

Do.—C (Mal.), Anon., 200 gr. Ms. 13294-D.

Grahaṇagaṇita X (ecl.), Mal. verse, Anon.

Beg. grahaṇam tanne eṇṇeṇṭil collunnuṇṭu curukki ñān /
rāhuketukkaḷoṭarkkan patimūnnatha tīyati //

Ms. PM. 4327-E (165 gr.)

Grahaṇanirṇaya (ecl.), by Nīlakaṇṭha Somayāji.

Ref. Q by the author himself in his *Āryabhaṭīya-bhāṣya*, (*TSS* 185, p. 102) and by others.

Grahaṇanyāyadīpikā (rationale of eclipses), by Parameśvara of Vaṭaśreṇi, in 85 verses.

Mss. 762-G ; M. S. Srinivasa Sastri, Palghat. Edn. and Tr. by K.V. Sarma, Hoshiarpur, 1966. Ref. Ul. Sup. I. 209-10.

Grahaṇaphalādi (astrol.), (Skt.-Mal.), Anon. Ms. 6914-B.

Grahaṇamaṇḍanam (ecl.), by Parameśvara of Vaṭaśreṇi, in two versions, of 89 and 100 verses (with two addl. verses), respectively.

Ms. 339-D, 788-B, C. 166-D, CM. 333-C, L. 1248-F; with K.V. Sarma. **Edn. and Tr.** by K.V. Sarma, Hoshiarpur, 1965. **Ref.** Ul. Sup. I. 207-8.

Grahaṇādigaṇita I (ecl.), Anon.

Beg. setau gām vāturāje...

Ms. 1085-C (inc., 150 gr.)

Grahaṇādigaṇita II (ecl.), Anon.

Beg. pātāsanne kharāṁśau yadi divasaniśor dṛśā pūrṇāvasāne.

Ms. 1092-F.

Grahaṇādigaṇita III (ecl.), Anon.

Mss. 12687-C (inc., 450 gr.), C. 472.

Grahaṇādigrantha (?) (ecl.), by Nilakaṇṭha Somayāji, an elaborate exposition of the tradition and rationale of eclipse computation and certain allied topics.

Ms. P. 975, latter portion; transcript with K.V. Sarma.

Grahaṇādiphalam (astrol.), Anon. **Ms.** 6914-B.

Do.—C (Mal.), Anon. **Ms.** 6914-B.

Grahaṇāṣṭaka I (ecl.), by Parameśvara of Vaṭaśreṇi.

Beg. bhāsvattuṅgau prasiddhau...

Mss. 475-K, C. 166-E, L. 1248-B-1, T. 179-B; Vayaskara Illam, Kottayam, No. 339-C; Eḷamprakkoṭṭu Mana, Eravoor, Trippunithura. **Edn.** and **Tr.** by K.V. Sarma, K.S.R. Inst., Madras, 1959.

Grahaṇāṣṭaka II (ecl.), by Putumana Somayāji (?), 25 gr.

Beg. sūryendvor grahaṇam sphuṭam gaṇayitum vakṣymy upāyam laghum ...

Mss. 1005-B, 5113-F, L. 1248-B-1. **Rem.** Authorship suggested on the basis of *Grahaṇagaṇita* I, which incorporates this work and has the characteristic initial verse of the Somayāji.

Do.—C (Mal.), Anon. **Ms.** 1005-B (inc., 120 gr.)

Grahaṇāṣṭaka III (ecl.), Anon., 25 gr., epoch, A.D. 1538. Exposition of a new method of Nīlakaṇṭha Somayāji.

Beg. kaṭākṣamālā yasyā hi kāmadāpi madhudviṣaḥ /
padmakiñjilkavarṇām tām namāmi kamalālayām //
mātaṅgavadanam natvā vāgdevīm ca gurūn grahān /
'Somasut'-sūtritāpūrvapakriyām vivṛṇomy aham //

Ms. 8358-H.

Grahaṇāṣṭaka IV (ecl.), unidentified.

Mss. C. 555-A, T. 323 (a few pages therein).

Do.—C I (Mal.), Anon. **Mss.** C. 555-A, T. 323 (a few pages therein).

Grahaṇopadeśa (ecl.), Anon., in 8 verses.

Beg. kāryas sūryendu... (1); māyāparvānta... (2); grāsam teṣviṣṭa ... (3).

Ms. With K.V. Sarma. **Rem.** Au. same as for *Grahaṇagaṇita* VII (?)

Do.—C II (Mal.), Anon.

Beg. grahaṇopadesattinnu collunnū— kāryas sūryendu iti. sūryagrahaṇam gaṇippān...

Ms. With K. V. Sarma. **Note.** Refers to an unidentified *Kriyākrama.*

Grahapañcadaśāphalam (astrol.), Anon. **Ms.** P. 875.

Grahaparīkṣākrama (astron.), by Nīlakaṇṭha Somayāji. Practical directions for scanning the skies and computing the planets.

Beg. Gargādismṛtanakṣatrakṣepayogakalāgatam...

End : iti saṅkṣepataḥ proktam parīkṣā jyotiṣām iha /
kālamānacatuṣkasya śrutasya vivṛtis tv iyam //

Edn. Q. in full in the au.'s *Aryabhaṭīyabhāṣya*, under Gola. 48, (*TSS* 185, pp. 132-49).

Do.—C. (Mal.), Anon.

Beg. bhagaṇaparidhyādikaḷākunna avaṯṯinnu oro ācāryanmār ororiṭattu oro prakāram collikkiṭakkunnu.

Ms. With K. V. Sarma. **Edn.**, in an adapted form, by P. S. Purushottaman Namputiri, Astr. Res. Inst., Bombay 25, 1950.

Grahabalādyānayanam (astrol.), (Mal. prose), Anon. Ms. L. 765-B.

Grahabhāvaphala (?) (astrol.), (Mal. verse), Anon.

Beg. pittam jvaram śirasi...murivum cirañnum /
pādakṣirogam udarasya ca raktadoṣam //
rājāricoraripuśastracatuṣpadānām /
kuṣṭham mahodaram apasmṛti sūryabhānau //

Ms. PM. 4077-A.

Grahamadhyamānanayanam (?) (kar.), (Mal. prose).

Beg. kali vaccu khaṇḍiccu raṇṭeṭattu vaccu onnine paṭu koṇṭu perukki...

Ms. L. 765.-B (inc., 35 gr.)

Grahasamaya : See *Aṅkaṇaśāstra*.

Grahasthitiphala I (astrol.), Anon.

Beg. atha grahāṇam svabalābalavaśāt jātayontibhāga (?) kriyate. prathamam tatra ja...yājanam āha— iṣṭakaṣṭaphala etc.

Ms. CM. 565-G.

Grahasthitiphala II (?) (astrol.), Skt.-Mal., Anon.

Beg. bahiṣṭhasvarkṣasaṁstheṣu nīcageṣūccageṣu vā /
sarveṣūpacayastheṣu caturṣv ekarkṣabheṣu va //

Ms. PM. 4321-B.

Grahasphuṭa I (kar.), Mal. verse, Anon. Ms. T. 255.

Grahasphuṭa II (kar.), Skt.-Mal., Anon. Ms. 13041-C.

Grahasphuṭaparilekhaḥ (?), (astron.), Anon., in 6 verses.

Beg. draṣṭā kendrasthitaś ced ... (1) ; svoccavyāsārdhavṛttam prathamam abhilikhed ... (2)

Ms. With K.V. Sarma.

Grahasphuṭavākyāni I (?) (kar.), Anon. Ms. 3638-B (100 gr.)

Grahasphuṭavākyāni II (?) (kar.), Anon. Ms. 5809 (1000 gr.)

Grahasphuṭānayana I (kar.), Mal. verse, Anon.

Beg. ādityasyodayattinnum madhyāhnāntattinum tathā /

Ms. T. 255 (inc., 450 gr.)

Grahasphuṭānayana II (kar.), Mal., Anon.

Beg. guṇakāraḥ kulam bhānor bhājako gotragāyakaḥ /
Ms. PM. 4331-A.

Grahāriṣṭa (astrol.), Anon. Ms. 13294-P.

Grahāvasthādivicāra (astrol.), Mal. verse, Anon. Ms. 5109-I.

Ghaṭīgopa, disciple of Parameśvara and devotee of God Padmanābha of Trivandrum, *c.* 1800.

—C on *Āryabhaṭīya* (Skt.)
—C on *Āryabhaṭīya* (Mal.), version I
—C on *Āryabhaṭīya* (Mal.), version II

Ref. See above, pp. 77-78. § 74 . Ul. III. 233-34 ; Ul. Sup. I. 535.

Caturasundarī : Name of C on *Cintājñāna*.

Candrakalānāḍī (astrol.), by Acyuta : See *Devakerala*.

Candrakriyā (kar.), Skt.-Mal. prose, Anon. Ms. 5806-A.

Candragaṇita (kar.), Mal. verse, Anon.

Beg. candrane sūkṣmamāyiṭṭu gaṇippān iha collinen /
aharganaṇatte vacciṭṭaṅṅiṣṭakālattinākkiyāl //
tatparāntam madhyamaṅṅaḷ varuttū candratuṅgayoḥ /

Ms. PM. 4368-G (75 gr.)

Candragaṇitakrama (kar.), (Mal.), by Śaṅkaran Nampūtiri of Mahiṣamaṅgalam.

Mss. PM. 4078-A, T. 251-B. Ref. Ul. II. 473.

Candragrahagaṇita (kar.), Mal. verse, Anon., 60 gr. Ms. L. 765-C.

Candracchāyāgaṇita I (kar.), by Parameśvara of Vaṭaśreṇi.

Beg. himaraśmicchāyāgaṇitam vakṣye hitāya daivavidām /
Āryabhaṭa-śāstrasiddham dṛkkarmadvitayapūrvakam //

Ms. 475-I (inc., 60 gr.)

Candracchāyāgaṇita II (kar.), by Nīlakaṇṭha Somayāji.

Beg. sūryendutuṅgapātau ca tadānīm ayanāṁśakān /
taddeśākṣam ca nirṇīya gaṇyatām śaśinaḥ prabhā //

Mss. 475 (f. 65), 5862-B, 5867 (ff. 173-77); Mad. R. 5185-(b).
Ref. Va. III. 391-92.

Candracchāyāgaṇita II (contd.)

Do.—C, by the author himself.

Ms. 5862-B (copied in Mad. R. 5185-b). Ref. Va. III. 391-92.

Candracchāyāgaṇita III (kar.), Anon.

Beg. nārṣā(?)lamūrtitvenūdye'tra tu... / arkendutuṅgapātau ca nītvā kuryād...

Ms. L. 1167-C (inc., with Mal. C., gr. 10).

Do.—C (Mal.), Anon.

Beg. ...kal pratipadam āyi oḷḷa pakkaṅṅaḷe eraṭṭippatu...

Ms. L. 1167-C.

Candracchāyāgaṇita (?) IV (kar.), Mal., Anon., 40 gr.

Beg. candracchāyakku collunnen tatkālārkkane veccatil /
ayanāṁśaṅṅaḷeccerttāl kūṭṭeṇam rāśiyāyatil //

Mss. 10647-G, PM. 4329-D.

Candracchāyāgaṇita (?) V (kar.), Mal., Anon.

Beg. viparītacchāya veṇam candranennaṅṅirikkilo /
viṣamam punarennālum collinen oru jāti ñān //

Ms. L. 636-C (inc., 40 gr.)

Candracchāyānayanopāyaḥ (?) (astron.), Anon.

Beg. atha pāramārthikāpakramādibhir vinā candracchāyānayane kañcin mārgam upadiśati—

kakhalagnapade lagnam natakālapade graham /
akṣasthāne ca dṛkṣepam kṣepam krāntipade 'pi ca //

Mss. C. 2314 (towards the end), C. 2470 (ff. 91b-92a).

Candranāḍī (astrol.), by Acyuta : See *Devakerala*.

Candrabhāṣā (kar.), Mal. verse, Anon., 50 gr.

Beg. śuddhamāyi gaṇikkeṇṭū candrārkanmāre eṅkilu /
khaṇḍaśeṣam muzhuvane vaykkeṇam udayattinu //

Mss. 4079, 4158-B, 4327-B.

Candralagnādiphala (astrol.), Mal. prose, Anon. Ms. 13475-E.

Candravākyādi (?) (kar.), Misc. mnemonic tables etc., Anon.

Ms. L. 1229-A (1000 gr.)

Candravākyāni I (kar.), by Vararuci : See *Gīrnaḥ śreyādi-Candravākyāni.*

Do. II : See *śīlam rājñaḥ śrīyetyādi-Candravākyāni.*

Candrasūryoparāgagaṇita (ecl.), Mal. prose, Anon. Ms. 1005-B.

Candrasputagaṇana-vākya (?) (kar.), Anon., 7 vākyas.

Ref. Below in the CC of this work.

Do.—C, in 2 verses, Anon. Men. Below in the CC of the work.

Do.—CC, Anon.

Beg. 'vākyair saptabhir' ādimair gaṇayitum candrasphuṭam yat purā
jyotiśśāstraviśāradena sudhiyā ślokadvayam proditam /
vyākhyām tasya karomy avismṛtikṛte natvā gajāsyam gurūn
sūryā — — kalāspadācchadhiṣaṇām satkālavin maṅgalān //

Ms. MC. 173-A (inc., 55 gr.)

Candrasphuṭagaṇita (?) III (kar.), Mal., Anon.

Beg. candracūḍanumāpākantanma kan gaṇanāthane /
caraticcu vaṇaṅṅiṭṭu kavimātineyum tathā //

Mss. 2243-C (under the title *Aharmānādigaṇitam*), (150 gr.), 4145-A (inc., 60 gr.)

Candrasphuṭādigaṇita I (kar.), Mal., Anon.

Beg. candrane sūkṣmamāyiṭṭu gaṇippān kriya collinen /
khaṇḍiccāl ara pokkeṇam antikkaṅṅu harikkilu //

Ms. 5811 (inc., 350 gr.)

Candrasphuṭādigaṇita II (kar.), Mal. prose and verse, Anon.

Beg. candrane sūkṣmamāyiṭṭu gaṇippān iha collinen /
aharga[ṇatte va]cciṭṭaṅṅiṣṭakālattinākkiyāl //

Ms. 14228-H.

Candrasphuṭāptiḥ (?) (kar.), Anon., related to the *Veṇvāroha* of Mādhava.

Beg. śiraḥ śaś mām (?) śikhāniṣyandicandrikaḥ /
anakāraharam divyam sindhubhūṣam bhaje mahaḥ //
adodho kramaśotkīrṇacandratattuṅgasaṅgamāt /
pratyaham vākyanavakāt sphuṭacandrāptir ucyate //

Ms. 1055-A (inc., 60 gr.)

Citrabhānu, (*c*. 1475-1550), Nampūtiri of the Gautama-gotra, from Śivapura (Covvaram), near Tirchur.

—*Karaṇāmṛta* (A.D. 1530)

Ref. *Ker. Astron*, p. 57, § 28; Raja, 153-55; Ul. 273-75; Ul. Sup. I. 305-6.

Citrabhānu-śiṣya, (*c*. 1525-75)

—C II on *Jātakapaddhati*

—*Bhāvacintāvalī*

Ref. *Ker. Astron.*, p. 57, § 29; Ul. II.275. **Note**: The maṅgala-ślokas of *Bhāvacintāvalī* and the anon. *Pañcabodha* II, C IV, *Grahaṇāṣṭaka* III, *Praśnabhāṣā* I and *Muhūrtapadavī* II, C V exhibit close similarity as to suspect their common authorship.

Cintājñāna or *Kṛṣṇīya* (astrol.), by Kṛṣṇa, in 32 chs., 1500 gr.

Mss. See *Ker.*, I. 165, and Mad., under *Kṛṣṇīya*. Edn. by P.S. Purushottaman Namputiri, with his own Mal. C, Quilon, 1106 M.E.

Do.—C, *Caturasundarī*, by Viṣṇu, 1500 gr.

Mss. See *Ker.*, I. p. 165 and Mad. under *Kṛṣṇīya*.

Cozhipraśna (pra.), Mal. prose, Anon., 305 gr. Ms L. 225.

Chāyāgaṇanāṣṭaka (?) (kar.), Anon.

Beg. abhyūhite candra ... (1); indūcconita ... (2); pātonāc ca (3).
Ms. With K.V. Sarma.

Chāyāgaṇita I (kar.), Skt.-Mal., Anon., 45 gr. Ms. 931-D.

Chāyāgaṇita (?) II (kar.), Anon., Mal. verse.

Beg. sūryacchāya gaṇikkeṇṭil tatkālārkane veccuṭan /
ayanāṁśaṅṅaḷ kūṭṭiṭṭu caravum krāntibāṇavum //
Ms. 5126-A (450 gr.)

Chāyāgrahaṇagaṇita (?) II. (kar.), Anon., prose and verse.

Beg. pāṭum pirappum eṇṇeṇṭil collunnuṇṭu curukki ñān /
iṣṭagrahayor arkan erunnāḷ udayattinu //

Ms. 13430-A (300 gr.)

Chāyāṣṭaka (kar.), by Acyuta Piṣāraṭi. Ms. P. 4116-A, in a misc. folio.

Janmavāraphalādi (jā.), Skt.-Mal., Anon. Ms. 4184-A.

[*Jātakakarmapaddhati, Jātakapaddhati* or *Śrīpatipaddhati* (jā.) by Śrīpati]

—C I, *Jātakālaṅkāra*, by Sūryadeva Yajvan.

Mss. See *Ker.*, I. 229 ; Baroda, Mad.

Do —C II, by Parameśvara of Vaṭaśreṇi.

Mss. 665, C. 2337-C ; Ad. Mad. ; Āzhvāñceri Mana List, 167-D.

Do.—C III (Mal.), Anon.

Beg. aviṭe naṭe ācāryan gurupraṇāmatte munpeṭuttu cikīrṣitatte pratijña ceyyunnū—natvā tām gurudevatām ...

Ms. C. 543-B. Ref. Ul. III. 237.

Jātakakramam (jā.), (Mal.), by Śaṅkaran Nampūtiri of Mahiṣamaṅgalam, 1500 gr.

Mss. 5129-H, C. 2173-A, C. 2216. Ref. Ul. II. 473.

Jātakagaṇita (jā.), Skt.-Mal., Anon. Ms. 13194-H.

Jātakacandrikā I (jā.), Skt.-Mal., Anon. Ms. 3634.

Jātakacandrikā II : Name of C by Parameśvara III, pupil of Śaṅkara, on *Hora*.

Jātakacintā (jā.), Mal. prose, Anon. Ms 13029-C.

Jātakanidhāna (jā), Mal. prose, Anon. Ms. L. 327-C.

Jātakapaddhati (jā.), by Parameśvara of Vaṭaśreṇi, in 44 verses.

Mss. See *Ker.*, I. p. 229. Edn. *Śrī Vañchi Setu Lakshmi Series*, No. 2, Trivandrum, 1926. Ref. Ul. II. 103 ; Va. III. 379-81, where it is taken to be by a different Parameśvara.

Do.—C I *Bālabodhinī* or *Bālaprabodhinī*, Anon., by a native of Vaikkom.

Beg. vyāghragrāmeśa ... (1) ; vidyādāyyapy avidyādam... (2) ;

Vaṭaśreṇīti loke 'smin prasiddhasya divijanmanaḥ /
kṛter vilikhyate vyākhyā svalpā *Jātakapaddhateḥ* //

Mss. 5097-B, C. 914-A, B, C. 1512-B, C.2478-E ; Āzhvāñceri List, 167-E. Ref. Ul. III. 89-90 ; Ul. Sup. I. 464 ; Va, III. 382-83.

Jātakapaddhati (contd.)

Do.—C II (Mal.), by a pupil of Citrabhānu, 400 gr.

Beg. natvā gaṇeśvaram vāṇīm Citrabhānvādikān gurūn / bhaktyā Jātakapaddhatyā kriyāmārgam vilikhyate // aviṭe naṭe—candrārkajanyarkṣakayoś ca patyoḥ...

Ms. C. 543-B.

Do.—C III (Mal.), *Bhāṣājātakapaddhati*, an exposition in verse, with extra matter, by Kṛṣṇadāsa (Koccu-Kṛṣṇan Āśān).

Mss. CM. 543-B, CM. 2123-B. **Edn.** *Śrī Vanchi Lakshmi Series*, No. 3, Trivandrum, 1926. **Ref.** Ul. III. 520, 523 ; Va. III. 384-85.

Do.—C IV (Mal.), by Śrīkaṇṭha of Veḷḷārakkāḍu (?)

Col. Śvetagrāmāṭavī-saṁśrita ... Śrīkaṇṭhaḥ kaścid etat sapadi likhitavān pustakam devadāsaḥ //

Edn In an adapted form, under the title *Balapiṇḍavum āyurdāyavum*, as app. to *Jātakādeśa*, ed. Kanippayyoor Sankaran Namputirippad, Kunnamkulam, 2nd edn., M.E. 1102.

Do.—C V (Mal.), Anon., 400 gr.

Beg. harihara-sarasiruhāsana ... (1) ; gaṇḍāntanirgalad ... (2) ; pañcāśadakṣara ... (3) ; Śrī-*Vaṭaśreṇi*-bhūdevaiḥ ... (4) ; aviṭe naṭe jananakālatte chāya koṇṭu tān ambuyantram koṇṭutān ...

Mss. 421-B, 1134-B, CM. 563-B ; Āzhvāñceri List, 167-B, Trippunithura Skt. Col. 804-B. **Ref.** Ul. III. 245-46.

Do.—C VI (Mal.), Anon., 240 gr.

Beg. perul— janmalagnasphuṭatte vaccu ayanacalanam kūṭṭiyatu...
Ms. 5880-C.

Do.—C VII (Mal.), Anon., 180 gr.

Beg. 'kuryāt sāyanalagnataś ca' ādyapadyam, 'sandhigrahāntarakālādi'padyam iti lagnasphuṭaṅṅaḷe sūkṣmamāyi varutti ...
Ms. L. 984.

Do.—C VIII (Mal.), Anon.

Beg. jananakālatte udayalagnam uṇṭākki ayanacalanam kūṭṭi caravum prāṇakalāntaravum koṇṭu...
Mss. P. 878 ; Trippunithura Skt. Col. 804-A.

Do.—See also *Jātakakarmapaddhati*, *Laghujātakapaddhati*.

Jatakaphalam (jā.), Mal. verse, Anon., 500 gr.

Beg. gurukkanmāre vandiccittavarāl uktamāyatil /
curukki *Jātakaphalam* kuraññonniha likhyate //
mūrttiyum kīrttiyum sthānam...

Mss. See *Ker. Mal.*, p. 60. Ref. Ul. III. 239; Ul. Sup. I. 537.

Jatakabhāvaphalam (?) (jā.), Anon., (Kar. ?).

Beg. astu trailokyadīpāya bhaktābhimatadāyine /
samastavidyānirmāṇakavaye ravaye namaḥ //
vṛttākṣo janavallabho 'ticapalo ...

Ms. C. 267-A (1700 gr).

Jatakamātṛka (jā.), Skt.-Mal., Anon,

Mss. 6007-D, C. 155-A, T. 147-A.

Jātakarahasya or *Keralanirṇaya* by Vararuci : See *Varaurucīkerala*.

Jatakalekhanakrama I (jā.), Mal., Anon., 400 gr.

Beg. ślokam mun toṭṭanāḷ pinne rāśiyum nāmadheyavum /
ādityādisphuṭam sarvam bhāṣayil kalināḷ punaḥ //

Mss. 8268-E, PM. 4329-E, T. 147-B, T. 154-B-4.

Jatakalekhanakrama II (jā.), Mal. verse and prose, Anon.

Beg. jātakam ezhutuvānuḷḷa kramaṅṅal collunnū. naṭe tanne gaṇapatikku kuṟiccu ...

Ref. Ul. III. 238.

Jatakalekhanakrama (?) III (jā.), Mal. verse, Anon.

Beg. iṣṭadevata vandiccāl iṣṭamām keṭṭanāḷiṭū /
lagnam drekkāṇavum perum grahatalkālavākyavum //

Ms. PM. 4117.

Jatakalekhanakrama IV (jā.), Mal. verse, Anon.

Beg. talkālārkkane vacciṭṭu vēṟe muppatu tīyati /
vaccāl atil kaḷaññiṭṭu arkanṟe bhāgaliptakaḷ //

Ms. PM. 4158-H.

Jātakasāra I (jā.), (Skt.) by Śaṅkara of Mahiṣamaṅgalam, 485 gr.

Beg. vande 'ham īśam girijāsametam ... (1) ; ajākhyam ādyam ca ... (2) ; siṁham ca kanyām ca ... (3).

Mss. PM. 4111-B, T. 268-C.

Jātakasāra II (jā.), Mal., by Śaṅkara of Mahiṣamaṅgalam, in 7 chs.

Beg. vande giriśam girijāsametam ... (1) ; santatiyum kaḷatravum nirūpikkeṇṭumpoḷ ...

Mss. P. 882 ; PM. 4026-C ; T. 144-D (a). Ref. Ul. III. 241-42.

Jātakasāra III (jā.), Mal. prose, by (a diff.) Śaṅkara, in 4 chs.

Beg. jātakam ezhutuvām naṭe lagnam niścayiccu ...

Ms. C. 1205-A (950 gr.)

Jātakasārasaṅgraha (jā.), by Āzhvāñceri Tamprākkaḷ, in 6 khaṇḍas. 184 verses.

Mss. C. 2431-D ; Ad. ; Mad.

Do.—C (Mal.), by the author himself.

Ms. L. 1217-A.

Jatakadeśamārga I (jā.), by Putumana Somayāji, 335 gr.

Beg. madiyahṛdayākāśe... (1) ; gaṇeśādīn namaskṛtya... (2) ; kujenduketu... (3)

End : guror lagneśadāreśa... ; suteśaśaśiśukreṣu... ;

Navālayavanākhyena dhīmatā *Somayājinā* /
kṛtam prakaraṇam hy etad daivajñajanatuṣṭaye //

Ms. CM. 2197-F.

Do.—C I (Mal.), Anon., 1100 gr.

Beg. eṉṉāl gaṇapati tuṭaṅṅiyuḷḷavaṟṟe namaskaricciṭṭu...

Mss. CM. 2197-G, L. 1092- C.

Do. C. II (Mal.), Anon. Ms. L. 1097-A.

Jātakadeśamārga II (jā.), by Putumana Somayāji (?) in 16 chs.

Beg. madiyahṛdayākāśe... (1) ; mūrdhāsya galaskandha.. (2) ; matsyau ghaṭi... (3) ; kriyatāvuru... (4) ; aruṇasita... (5)

End. tatra śubhāśubhayogā...

Jatakadeśamarga II (contd.)

Edn. By Kanippayyoor Sankaran Namputirippad, 5th edn., Kunnamkulam, M. E. 1125; By V. N. Sankunni Nair, A.R P. Press, Kunnamkulam, M.E. 1105.

Jātakādeśaratna (jā.), by Nārāyaṇan Iḷayatu of Maccāṭ, being an adaptation of the *Jātakādeśamārga* of Putumana Somayāji.

Men. By the author's grandpupil, Puruṣottama III, in his *Praśnāyana*, III. 19; VIII. 81. **Ref.** Ul. III. 529; Ul. Sup. I. 225.

Jātakanītimārga (jā.), by Āzhvāñceri Tamprākkaḷ, in 14 khaṇḍas, 166 verses. **Ms.** C. 2331-A.

Do.—C (Mal.), by author himself, 1300 gr. **Ms.** C. 2431-B.

Jātakābharaṇam (jā.), by Acyuta Piṣāraṭi.

Beg. mūrtitva parikalpitaḥ... (1); ṣaḍānām... (2); guṛūṇām caraṇāmbhoja... (3); Varāhahorām ālokya... (4)

Ms. C. 2139-A. **Ref.** Ul. II. 324.

Jātakālaṅkāra: Name of Sūryadeva Yajvan's C on *Jātakakarmapaddhati*.

Jātakodaya or *Uḍujātakodaya* (jā.), Anon., by a Brahman of Veṇāḍ in S. Kerala, 103 verses.

Beg. gurūn upāsya śāstrāṇi samāloḍyābhiyujya ca /
niścityāvyabhicāritvam kriyate *Jātakodayaḥ* //

End. *Dvijena* kenāpy *Uḍu-Jātakodayam*
kṛtam dvi-(?) *Veṇāṭikadeśajanmanā* /
trayādhikślokaśatena nirmitam
hitāya taj jātakasāravedinām //
sarvoktam etc.

Mss. 1004-D C. 1912-E, L. 1248-D, P. 883, T. 283.

Jīvanayanam (?) (astron.), Anon., misc. composition.

Beg. nihatya cāpavargeṇa cāpam tattatphalāni ca /

Ms. 8358-C (inc., 100 gr.)

Jīvādyānayanam (?) (astron.), Mal. verse, Anon.

Beg. anūnanūtnānanununnanityaiḥ...

Ms. 14152-C (inc., 75 gr.)

Jyāḥ I (astron.), mnemonic sine tables etc.

Beg. gaṇānām adhipas caṇḍo gajavaktravilocanaḥ /
prīto bhavatu me nityam varadātā vināyakaḥ //
janena satyena...

Ms. C. 595-C (140 gr)

Do II. Mss. See *Ker.*, I. p. 238 ; *Ker. Mal.*, p. 62.

Jyākhaṇḍadyānayana (?) (astron.), Mal., Anon.

Ms. T. 323 (inc., 1910 gr.)

Jyāgaṇita (?) (astron.), Anon.

Beg. lakuṭena samabhyastā rāśicakrakalā haret /
śalmaleti stutir labdhā tadartham tridamaurvikā //

Ms. L. 765-G.

Do.—(Mal.), Anon. Ms. L. 765-G (160 gr.)

Jyeṣṭhadeva, (1500-1610). of the Parañṅoṭṭu family in the Ālattūr village ; pupil of Dāmodara and teacher of Acyuta Piṣāraṭi.

—*Gaṇitayukti*

—*Dṛkkaraṇam* (Mal.)

—*Yuktibhāṣā* (Mal.)

Ref. See above, pp. 59-60, § 32 ; K. V. Sarma, 'Jyeṣṭhadeva and his identification as the author of *Yuktibhāṣā*', *Adyar Lib. Bulletin*, 22 (1958) 35-40; Raja, 156-58.

Jyeṣṭhadeva-śiṣya, (*c.* 1550-1625).

—C in verse on *Tantrasaṅgraha*.

Ref. *Ker. Astron*, p. 60, § 33; Raja, 158.

Jyotiśśāstrasaṅgraha (astron.-astrol.), by Azhvāñceri Tamprākkaḷ, in two parts : I. *Siddhāntaskandha* or *Gaṇitaskandha*, and II. *Horāskandha* (*Muhūrta*, *Jātaka* and *Praśna*).

Mss. CM. 6-A, L. 1179, L. 1221-A, T. 1156 : Vaṭavarkkoṭṭu Mana, Venkitangu, List II. 12-A. Note. For an exposition of the principles involved, see *Saṅgrahasādhanakriyā*.

Do.—C (Mal.), by the author himself.

Mss. See *Ker. Mal.*, p. 42 (under *Gaṇitasaṅgraha*) ; p. 62 ; Vaṭavarkoṭṭu Mana, Venkitangu, List II. 12-B.

Jyotisadīpamūla (astron.-astrol.), Mal. verse, Anon. 5 chs., 750 gr.

Beg. gaṇapatiguruvāṇīm arkacandrārasaumyān
suragurusitamandam rāhuketum vaṇaṅṅi /
gaṇitam api muhūrttam jātakam praśnabhāgam
laghutaram iha collām mandadhīdhāraṇāya //

Mss. See *Ker. Mal.*, pp. 62-63; C. 1864-C. Ref. Ul. II. 228-29.

Jyotiṣapaddhati (astron.-astrol.), Mal. verses, Śītaṅkan tuḷḷal, Anon.

Ms. 10967-C.

Jyotiṣaprakāśa : Name of C by Rājarāja Varmā Koyittampurān on the *Goladhyāya* of Bhāskara II.

Jyotiṣapradīpa (astron.), Mal., by Rāma Varma Koyittampurān of Gramam.

Ref. Ul. IV. 545.

Jyotiṣabhāṣāccarttu (astrol.), Mal., Anon. Ms. L. 1250.

Jyotiṣabhāṣāvalī or *Māccāṭṭu Bhāṣā* (astron.-astrol.), Mal., by Nārāyaṇan Iḷayatu of Maccāṭṭu house. Ref. Ul. III. 529; Va. IV. 221.

Jyotiṣavākyāni (mnemonic sine and other tables), Anon. Mss. See *Ker.*, I. p. 239.

[*Jyotiṣasaṅgraha* I (astrol.), Anon.]

—C (Mal.), Anon.

Beg. pañca prācīr ālikhed bāṇasaṅkhyāḥ
tiryagrekhāvarjitāntāś catuṣkāḥ /
prāgādīśā dvādaśavyomavāsāḥ
jyotiścakrasvāminas tūbarādyāḥ //

Ms. Mad. D. 13765.

Jyotiṣasaṅgraha II (astrol.), Mal., by a pupil of Maṅgalaśreṇivipra.

Beg. *Maṅgalaśreṇīviprendugurupādāmbujadvayam* /
vandiccittu camaykkunnen Bhāṣā-*Jyotiṣasaṅgraham* //

Ms. T. 142 (inc., 120 gr.)

Tamprākkaḷ Bhāṣā : Nama of the Mal. C-s of Azhvañceri Tamprākkaḷ on his several works and on the *Muhūrtapadavī*, esp. the last.

Tantrasaṅgraha I (astron.), by Nīlakaṇṭha Somayāji, in 8 chs., 450 gr., A.D. 1500.

Mss. See *Ker.*, II. pp. 16-17; Ad.; Mad. Edn. *TSS* 188. Ref. Ul. II. 118.

Do.—C I, *Kriyākalāpa*, by Śaṅkara Vāriyar of Tṛkkuṭaveli.

Beg. tatra tāvat kalyāder ārabhya yātān abdān dvādaśabhir nihatya......

Ms. L. 1329-A (2000 gr.) Ref. *Ker. Astron.*, pp. 58-59, § 31.

Do.—C II, *Laghuvivṛti*, by Śaṅkara Vāriyar of Tṛkkuṭaveli.

Mss. See *Ker.*, II. pp. 16-17; Mad. Edn. *TSS* 188. Ref. Ul. II. 120-21; Va. II. 498-99.

Do.—C III, in verse, by an anon. pupil of Jyeṣṭhadeva, for chs. I-IV only ; 2600 gr.

Mss. 586-E, C. 1375, L. 1302; Mad. R. 2505. Ref. Ul. II. 120; Va. II. 498.

Do.—C IV, *Laghuvyākhyā*, anon., possibly by a Tamil astronomer.

Mss. Panjab Univ. Lib., (Lahore), *Catal.*, II, p. 220, mss. nos. 3494, 3495, both in grantha script.

Do—C V (Mal.), Anon.; 4300 gr.

Beg. aviṭe ācāryan ārambhippānāyikkoṇṭu icchikkappeṭṭirikkunna *Tantrasaṅgrahattinṟe*...

Mss. See *Ker.*, II. p. 17; *Ker Mal.*, p. 64.

Tantrasaṅgraha II (astron.), Mal. prose, Anon., Mss. 8380, T. 211-C.

Tantrasaṅgrahāt Sphuṭanirṇayabhagaṇāḥ (?) (astron.), Anon.

Beg. *Tantrasaṅgraha*-samprokta-kalyādi-dhruvaparyayaiḥ / *Sphuṭanirṇaya*-samproktā bhagaṇānītir ucyate //

Ms. With K.V. Sarma.

Tantrasāra (astron.), by Nārāyaṇa of Perumanam village.

Ms. With Rāma Varmā Maru Tampurān of Chalakkudi.

Ref. Raja, 153.

Do.—C (Mal.) Ms. With the text above.

Tāmaranallūr

—*Muhūrtam-Bhāṣā* or *Tāmaranallūr Bhāṣā*.

Ref. *Ker. Astron.*, p. 49, § 18.

Tāmaranallūr-Bhāṣā : See under *Muhūrtam Bhāṣā*.

Tāmbūlapraśnādiphalam (pra), Mal. verse, Anon. Ms. L. 1187-C.

Tāmbūlādipraśna (pra.), Mal. prose, Anon. Ms. 3383-H.

Tithinakṣatrādiphalam (astrol.), Mal. prose, Anon. Ms. L. 247.

Tithinirṇaya (astron.), Mal. verse, Anon. Ms. L. 336-B

Tuppan Nampūtiri, (*c.* 1725-1800), of Iṭavaṭṭikkāṭṭu family in Central Kerala.

—*Muhūrtapadavī* VI

Ref. *Ker. Astron.*, pp. 59-60, § 59 ; Ul. III. 470-76.

Tṛppāṇikkara Putuvāl, (17th cent.), astrological authority, pupil of Acyuta Piṣāraṭi. Ref. *Ker. Astron.*, p. 5.

Trirāśijyāvākyāni (?), misc. astron. mnemonics. Ms. L. 1328 (40 gr.)

Dakṣiṇārmūrti Mūssatu of Maṅgalaśśeri, (18th-19th cent.), astrological authority, Ref. *Ker. Astron.*, p. 5.

Daśapporuttam (astrol.), Skt.-Mal., Anon., 10 gr. Ms. C. 2421 E.

Daśādhyāyī : Name of C by Govinda Bhaṭṭatiri on *Horā*.

Daśāphalavicāra (artrol.), Anon. Ms. Pāliyam List, 634.

Daśāvatārappaṭṭika (astron.), Mal. prose, Anon., 150 gr. Ms. 13475-D.

Daśāviśeṣaphala (astrol.), Ms. Pāliyam List, 614.

Dāmodara I, (15th cent.), of Vaṭaśreṇi, son of Parameśvara and teacher of Nīlakaṇṭha Somayāji. Ref. *Ker. Astron.*, pp. 54-55, § 24,

Dāmodara II : Dāmodaran Nampūtiri, (*c.* 1675-1775), of Maṅgalaśśeri in Perumanam in N. Malabar.

—*Praśnarīti* 1

—C on *Līlāvatī*

Ref. *Ker. Astron.*, pp. 65-66, § 42 ; Va. III. 378-79.

Damodara III of the Bhāradvāja gotra, brother of Keśava, hailing from Cellūr.

—*Muhūrtābharaṇa*

Dūtalakṣaṇa-bhāṣa : See under *Āyudhalakṣaṇa.*

Dṛkkaraṇam (kar.), by Jyeṣṭhadeva (?), in 10 chs., 475 gr., A.D. 1608.

Ms. C. 7-C. Ref. For the tradition that the au. is the same as the au. of *Yuktibhāṣa* (*i.e.*, Jyeṣṭhadeva), see M. Whish, *Trans. Royal As. Soc.* 3 (1835) 523. On the work, see Ul. II. 478 ; Ul. Sup. I. 226.

Dṛkparahitam (kar.), Anon.

Beg. nītvā madhym viliptāvadhikam urudhaīādyāptahīne dhruvāḍhye kṣiptvāsmin deśabhedam ravibhujacarayor ...

Ms. Mad. D. 13447 (cata. as *Pañcāṅgagaṇitaviṣaya*).

Dṛggaṇita (kar.), by Parameśvara of Vaṭaśreṇi.

Mss. 411-B, 13300-E, L. 1248-E, L. 1243-I ; with K.V. Sarma.

Edn. K.V. Sarma, V.V.R. Inst., Hoshiarpur, 1963. **Ref.** Ul. II. 102 ; Va. I.379-80.

Dṛggaṇitakrama (?) (kar.), Anon., Mal. verse.

Beg. kulina-rūkṣajña-vidhāna-mātrayā ...

Ms. PM. 4116 (320 gr.)

Dṛggaṇitajyāvākyāni (kar.). Ms. Baroda, p. 1198 (ms. no- 9942-d).

Dṛggaṇitaprakāra (?) (kar.), (Mal.), Anon.

Beg. ini Dṛggaṇitattinṟe prakāram paṟayinnitu—

arkano bhedamillallo dṛkkil parahitattilum /
kujannu madhyame dṛkkil bhedamilliha tuṅganum //

Ms. 189-B.

Dṛg-veṇvārohakriyā (kar.), Anon. Epoch : A.D. 1695. **Ms.** 5867 (ff. 163-65). **Edn.** K.V. Sarma, App. II to his edn. of *Veṇvāroha*, Trippunithura, 1956.

Dṛṣṭāntapraśna (pra.), Old Mal., Anon., 298 gr.

Beg. ādiyām paramakalyāṇi uḷḷattill ninnum kuṭikoḷḷunna uḷḷamuṭyān rakṣa rakṣa. Śivālayam—
(na)lam itu karumam naṇṭa ānattol viṣṇuviṇāle
itam paṭavuratten colluvaṭināl Agastyan keḷkka
nītiyāl pūtalattil vāḷka, oḷḷatellām arivināl.

Ms. PM. 4125-A.

Dṛṣṭāntamālā or *Śakunamuṣṭi* I (pra.), Old. Mal., Anon., in the form of questions and answers.

Beg. I rājāvinekkaṇṭāl śubhamo aśubhamo ennu collu.

Mss. PM : 4122, 4123, 4125-B, 4126, 4309.

Dṛṣṭāntamālā or *Śakunamuṣṭi* II (pra.), Old. Mal., Anon.

Beg. innirupicca kāryam śubhamo aśubhamo ennu. innurupicca kāryam ninacca vaṇṇam varum. iviṭe devālayam uṇṭākkiyāl guṇam varum. Ms. PM. 4124.

Devakerala (astrol.), called also *Keralajyotiṣa*, *Keralarahasya*, *Candrakalā-nāḍi* and *Candranāḍī*, by Acyuta I, a 'Kerala-brāhmaṇa'.

Mss. Mad. D. 13775-79, R : 853-a, 3322, 4056 ; Ad. **Edn.** Gov. Or. Mss. Lib., Madras, 3 vols., 1952-56. **Ref.** Ul. I. 164.

Daivānukūlyādi (astrol.), Anon.

Beg. atha daivānukūlyādikam nirūpyate.
devair vā dharmadevaiḥ phaṇipatigurubhir brahmaṇaiḥ pretabhūtaiḥ /

Ms. C. 584-C.

Drekkāṇādivicāra (astrol.), (Skt.-Mal.), Anon. **Ms.** 13494-H.

Dviśatī or *Prakāśalatikā* (astrol.), Anon., by a devotee of Śiva installed at Talipparamba (Cellūr) in N. Kerala and protege of the Nampūtiri family of Vāraṇakkoḍ.

Beg. yasyānuvelam udaye ... (1) ; lakṣmīpureśam ... (2) ; dvaimāturam ... *Prakāśalatikām Dviśatīm* likhāmi //3//

Ref. Va. III. 611-15.

Nakṣatram nokkal ('star gazing'), (Mal.), Anon., a single verse to derive the time for sunrise from the position of a star.

Verse : uccappeṭṭoru nakṣatram teṭṭeṭṭoḷm punar aṅṅineyeṇṇi /
eṭṭiṅkēnnatu ñāṯṯilayoḷam atrayum atrayum arkan udippān //
sūryan udippān ini etra samayam uṇṭennaṟivān.

Ref. Q in 'Samayam nirṇayikkāṉ' by M.R. Vargheese, *Mathrubhumi Weekly*, (Kozhikode), 7-11-1954, p. 45.

Nakṣatrappāna (astron.), Mal. verse, Anon., 20 gr.

Beg. oṇam mūnnu muzhakkol pol
uccaykku meṭattil cellum onnara nāzhika.

Ref. 5038-C, 14228-D, PM. 4328-C, PM. 4368-D.

Naraceṣṭā (pra.). Anon., (Ker. ?)

Beg. ādityādīn grahān natvā śubhāśubhasusūcakān /
yathāśāstram yathāpraśnam *Naraceṣṭām* pracakṣmahe //

Ms. C. 2137-C.

Navagrahavākyāni (?), (mnemonic tables in verse form), Anon., 30 gr.

Beg. devo vanālokanapūjanottamaḥ.

Ms. 11044-V.

Navagrahasamaya : See *Aṅkaṇaśāstra*.

Naṣṭajātakakriyā (astrol.), Mal. prose, Anon. Mss. 13487-D, L. 1217-D.

Naṣṭajātakapraśna (pra.), Mal. prose, Anon. Ms. 794-B.

Naṣṭajātakādi (astrol.), Skt.-Mal., Anon. Mss. 10999-A ; Vayaskara Illam, Kottayam, 92-B.

Nārāyaṇa I, (*c.* 1500-75), pupil of another Nārāyaṇa and admirer of Nīlakaṇṭha Somayāji.

—*Uparāgakriyākrama*

—C *Karmadīpikā* or *Kriyākramakarī* on *Līlāvatī*, Version I

—C Do. Do. Do., Version II

—C (I), *Laghuvivṛti* on *Pañcabodha* IV.

Ref. *Ker. Astron.*, p. 57-58, § 30 ; Ul. II. 121 ; Ul. Sup. I. 227-28.

Nārāyaṇa II, son of Keśava, resident of Kāṇvavastu (Tṛkkaṇṇapuram or Kaṇṇanparuampu) in Malabar.

—*Muhūrtadīpaka*

Ref. *Ker. Astron.*, p. 62, § 35 ; Ul. II. 107 ; Va. II. 612-13.

Nārāyaṇa III

—*Laghudarśinī*

Ref. *Ker. Astron.*, p. 65, § 41.

Nārāyaṇa IV : Nārāyaṇan Nampūtiri (18th cent.) of Iṭavaṭṭikkāṭṭu family in Central Kerala.

—*Muhūrtapadavī* VII

Ref. *Ker. Astron.*, p. 73, § 60 ; Ul. III. 470-76.

Nārāyaṇa V, of Perumanam village.

—*Tantrasāra*

Ref. *Ker. Astron.*, 74, § 64 ; Raja, 153.

Nārāyaṇa VI : Nārāyaṇan Iḷayatu of Maccāṭ (1765-1843).

—*Jātakādeśaratna*

—*Jyotiṣabhāṣāvali* or *Maccāṭṭu Bhāṣā* (Mal.)

Ref. *Ker. Astron.*, p. 76, § 71 ; Ul. III.527-29 ; Ul. Sup. I.648-49 ; Va. IV. 216-21.

Nārāyaṇa VII, (*c.* 1325-1400), son of Parameśvara and teacher of Parameśvara (promulgator of *Dṛggaṇita*). Ref. *Ker. Astron.*, p. 53, § 23.

Nārāyaṇa VIII, (19th cent.), teacher of Puruṣottama (au. of *Praśnāyana*). Ref. *Ker. Astron.*, p. 79, § 79.

Nāvāyikkuḷattu Āzhāti, (17th cent.), astrological authority.

Ref. *Ker. Astron.*, p. 5.

Nālum pakkavum aṟivān (kar.), (Mal.), computation of day, tithi, etc. Anon.

Beg. akārādi patimūnnakṣaram śūnyam. oṭukkatte akṣaram kāryam ākunnatu.

Ms. C. 9-F.

Nāzhikamaṇiyuṭe yukti (Mal.). Anon., a detailed exposition of the pendulam clock. Ms. With K.V. Sarma.

Nityaprakāśa Yati or °**Bhaṭṭāraka**, pupil of Ānandaprakāśa.

—C *Prakāśikā* or *Viṣamākṣaravivṛti* on *Horā*.

—C *Prakāśikā* (Mal.), on *Horā*

Ref. *Ker. Astron.*, p. 50, § 19.

Nimittapraśna (pra.), Mal. prose, Anon. **Ms.** L. 28.

Nirgaṇita (kar.), Anon. **Men.** In the *Karaṇapaddhati* of Putumana Somayāji, IV. 3.

Nihatya cāpavargeṇetyādi-ślokaḥ : See *Mahājyānayanaprakāraḥ*.

Nīlakaṇṭha I : Nīlakaṇṭha Somayāji, (1444-1545), of the Garga-gotra. of Kerala-sad-grāma (Mal. Keḷallūr) ; pupil of Dāmodara and grand-pupil of Parameśvara I.

—*Gaṇitadarpaṇa* (?)

—*Golasāra*

—*Grahaṇanirṇaya*

—*Grahaṇādigrantha*

—*Grahaparīkṣākrama*

—*Candracchāyāgaṇita*

—*Tantrasaṅgraha*

—*Siddhāntadarpaṇa*

—*Sundararājapraśnottara*

—C *Bhāṣya* on *Āryabhaṭīya*

—C on his own *Candracchāyāgaṇita*

—C on his own *Siddhāntadarpaṇa*

Ref. *Ker. Astron.*, pp. 19, 22-23 ; 55-57, § 26 ; K.V. Sarma, Gārgya Kerala Nīlakaṇṭha Somayājin', *Jl. of Or. Res.*, 26 (1956-57) 24-39 ; Raja, 143-52 ; Sen, pp. 155-57 ; Ul. II. 117-20 ; Ul. Sup. I. 235-37 ; Va. I. 383-87.

Nīlakaṇṭha II, (16th-17th cent.)

—*Kaṇakkusāram* (Mal.)

—C (Mal.) on *Kaṇakkusāram*.

Ref. *Ker. Astron.*, p. 65, § 40.

Nilakaṇṭha III : Nilakaṇṭha Śarmā of Punnaśśeri, (1858-1935).

—*Jyotiśśāstra-subodhinī* (Mal.)

—C (Mal.) on *Camatkāracintāmaṇi*

—C (Mal.) *Pañcabodhakriyā-Bhāṣā* on *Pañcabodha*

—C (Mal.) *Uparatnaśikhā* on *Praśnamārga*

Ref. *Ker. Astron.*, p. 81, § 81 ; Ul. V. 964-70 ; Ul. Sup. II. 500 ; Va. V. 192-204.

Nyāyaratna, version I (astronomical rationale), by Putumana Somayāji, in 8 chs., 120 gr.

Beg. madīyahṛdayākāśe cidānandamayo guruḥ /
udetu satatam samyag ajñānatimirāruṇaḥ //
namaskṛtya gurūn bhaktyā...(2) ; anuktāviha sarvatra...(3) ;
tulājādigatam svarṇam ... (4).

End : apakrāntyayanāntastha ... ; koṭikrānteḥ ... ; nyāyapradarśanāyaivam ...

Mss. 414-C, 597-B, 11013-B ; C. 964-A ; T. 464-A ; Mad. R. 5344.

Nyāyaratna, version II (astronomical rationale), by Putumana Somayāji, in 8 chs., 120 gr.

Beg. madīyahṛdayākāśe ... (1) ; namaskṛtya gurūn bhaktyā...(2) : iha grahāḥ sphuṭikāryāḥ ... (3) ; kujāder antyakendrottha ... (4) ; antyakendrabhujābhāve ... (5).

End : yugmaujapadajam... ; svadoḥkrāntyukta...; alpakrāntyāyanāntastha ... : nyāyapradarśanāyaivam ...

Ms. With K.V. Sarma.

Pakiṭapraśna (pra.), Mal. prose, Anon., 550 gr. Mss. 4133, 10964.

Pakṣiśāstram or *Pañcapakṣiśāstram* (astrol.), (Skt.-Mal.,) Anon., based on Agastya's *Pañcapakṣiśāstra* (For mss. of which see Tanjore D. 11489-92), 100 gr.

Beg. abhivandya gaṇeśānam ... (1)

natvā vighneśvaram vāṇīm Pañcapakṣinidarśanam /

pur-Āgastyena devebhyaḥ proktam saṅkṣipyate mayā //

Mss. C. 350-A, P. 589. **Ref.** Ul. III. 243 ; Ul. Sup. I. 539 ; Va. II. 503.

Pañcapakṣilakṣaṇam (astrol.), Old Mal., verse, Anon.

Beg. covvā ñāyiṟu vallıra ciṟanta tiṅkaḷ budhan ānta /

Ms. PM. 4154.

Pañcapakṣiśāstram or *Pakṣiśāstram* : See under *Pakṣiśāstram*.

Pañcabodha I or *Prakīrṇasaṅgraha* (kar.), in 10 *khaṇḍas*.

Beg. yātāś ca māsā divasāś ca nāḍyaḥ svābhīṣṭakālāvadhikāḥ kramena /

(**Some mss. prefix a benedictory verse : yair aṁśakaiḥ sarva-guhāśayasya ... The col. in several mss. read :** *iti Prakīrṇa-saṅgrahaḥ*)

Mss. 597, 831-B, 5376-B, 5864-B, 8985, 12455, C. 77, C. 364, C. 588, L. 1360-A. **Edn.** Kanippayyoor Sankaran Namputirippad, with modern com. in Mal., Panchangam Press, Kunnamkulam, M.E. 1102 ; M.E. 1107.

Do.—C (Mal.), Anon.

Beg. yogyādikānam tu yathoraḍeśam ... **Mss.** 5376-B, 11061-L.

Pañcabodha II (kar.), Anon.

Beg. viṣuvaddyugaṇam nyasya māsavākyam dināni ca /
yuktvā śukrādivāram ca jñātvā khaṇḍam viśodhayet //
śeṣam guṇena saṁhṛtya ...

Ms. P. 890-A.

Do.—C (Mal.), *Pañcabodhakriyākrama* by Śaṅkaran Nampūtiri of Mahiṣamaṅgalam.

Beg. tumpa tiṅkaḷoṭu gaṅga tanneyum ...

Ms. P. 890-A.

Pañcabodha III (kar.), by Putumana Somayāji in five *khaṇḍas* on *Vyatīpāta*, *Grahaṇa*, *Chāyā*, *Śṛṅgonnati* and *Mauḍhya* ; 85 gr.

Beg. devarṣigaṇais sevyam ... (1) ; madīyahṛdayākāśe ... (2) ; golānte dviguṇāyanārkarahite prāyo vyatīpātabham ...

Mss. 414-A, T. 150-A, B ; Mad. Mal. D. 339, (pp. 1-7). **Rem.** Authorship based on the characteristic intro. verse, *madīya-hṛdayākāśe* etc. and the authority of Punnaśśeri Nīlakaṇṭha Śarmā, *vide* his *Jyotiśśāstra-subodhinī*.

Pañcabodha III (contd.)

Do.—C (Mal.), Anon., 800 gr.

Beg Pañcabodhakriyāślokavyākhyānam iha bhāṣayāy /
gurūktarītyā collunnen bālānām arivān aham //

Mss. L. 893, T. 150-A, B.

Pañcabodha IV (kar.), Anon., in 5 *paricchedas* on *Vyatīpāta, Maudhya, Chāyā, Śṛṅgonnati* and *Grahaṇa*, in 105 verses.

Beg. sarveṣām jyotiṣām ādyam namaskṛtya divākaram /
laghūkṛtya vidhāsyāmi vyatīpātādibodhanam //
yāvanmūlāntam ādityāj jalarkṣādeś ca tāvati /

Mss. 475-G, 11103, C. 173-H, C. 595-B, L. 843-A, P. 923-B; PM. 4147-B; Mad. R. 2754 (b) (under the title *Lāṭādipañcakam*).

Do.—C I, *Laghuvivṛti*, by Nārāyaṇa; A.D. 1529; 600 gr.

Beg. bhāsvantam andhatamasam ... (1); samastāny api karmāṇi ... (2); yatprasādād kavīndratvam ... (3): śaktyā śaśvan nikhila ... (4); Nārāyaṇam jagadanugrahajāgarūkam /
vidvattamam guṇanidhim sudṛḍham praṇamya /
lāṭādipañcaka-vibodhakarasya *Pañca-bodhasya cāru-vivṛtim* vilikhāmi *Laghvīm* // 5 //
granthakāraś śiṣṭācāram anusaran ...

Mss. 411-A, T. 1184; Mad. R. 2754 (b); with K.V. Sarma.

Do.—C II (Mal.), *Pañcabodhārthadarpaṇam*, by Śaṅkaran Nampūtiri of Mahiṣamaṅgalam.

Beg. śrīsūryādīn namaskṛtya gurum ca Parameśvaram /
balāyāsmai vidhāsyāmi *Pañcabodhārthadarpaṇam* //

Mss. 10647-B. **Ref.** Ul. II. 472.

Do.—C III (Mal.), *Pañcabodhakriyākraman* or *Bālaśaṅkaram*, by Śaṅkaran Nampūtiri of Mahiṣamaṅgalam.

Beg. dhātrī yatkarasamparkād ... (1); tumpa tiṅakḷoṭu gaṅga tanneyum ... (2); bālānām Pañcabodhārtham ... (3);

bhāskarādīn vaṇaṅṅiṭṭu gurum ca Parameśvaram /
cerutoṭṭezhutunnuṇṭu *Pañcabodhakriyākramam* //

gaṇitattinnu Pañcabodhamākunna karaṇatte camappān tuṭaṅṅunna ācāryan ...

Pañcabodha IV (contd).

Mss. 3761-D, 10625, 10987-B, C. 173-L, C. 563-D, C. 2146-B, L. 1167-B. **Ref.** Ul. II. 472.

Do.—C IV, *Pañcabodhakriyākrama*, (Mal. verse), Anon.

Beg. gaṇeśānam gurum vāṇim vaṇaṅṅikkoṇṭu bhāṣyāy /
ceṟuoṭṭezhutunnuṇṭu *Pañcabodhakriyākramam* //

annannu bhāskaran ninna nāḷ toṭṭāmūlam eṇṇuka /
pūṟāṭād atra cennuḷḷa nāḷil annuḷḷa lāṭamām //

Mss. PM. 4366 (cata. *Vyatīpātagaṇitam*), PM. 4368-I. **Rem.** Apparently related to C III above.

Pañcabodha V or *Pañcabodhaśataka* (kar.), by Puruṣottama II

Beg. (*Grahaṇa* sn.) :

namaskṛtya guroḥ pādam mandajñānabhido varam /
sūryendvor uparāgoktavidhānam pravadāmy aham //

Col. *Puruṣottamakṛte Pañcabodhaśatake* Uparāgaparicchedaḥ sampūrṇam.

Ms. With K.V. Sarma. **Ref.** Ul. Sup. I. 224-25.

Pañcabodha VI (kar.), Anon.

Beg. arkendvor apamāntare 'pi padayos tadbimbayogārdhataḥ.

Ms. 8112.

Do.—C (Mal. prose), *Pañcabodham Bhāṣā*, Anon.

Beg. gurupādāmbujam natvā sarvadāśāsitārthadam /
*Pañcabodh*oktapaddhatyā *Bhāṣām* iha likhāmy aham //

aviṭe naṭe ācāryan vyatipātalakṣaṇatteyum ...

Ms. 8112.

Pañcabodha VII (kar.), Anon., on the computation of *Chāyā*, *Grahaṇa*, *Vyatīpāta*, *Mauḍhya* and *Śṛṅgonnati*.

Beg. iṣṭas sāyanabhāskara ... (1) ; kṛtāyaneṣṭārka ... (2) ; chāyeṣṭaśaṅkukṛti ... (3).

Ms. With K.V. Sarma.

Do.—C (Mal.), Anon.

Beg. iṣṭadeśa-kālaṅṅaḷil sāyanārkasphuṭatte veccu ...

Ms. With K.V. Sarma.

Pañcabodha VIII (kar.) Anon., interspersed with Mal.

Beg. sindūrāruṇam indukāntivadanam keyūrahārādibhiḥ ... (1); sūryaḥ somo budhaḥ śukraḥ ... (2); guṇakāraḥ kulam bhānoḥ ... (3).

Ms. 4124-B.

Pañcabodha IX (Kar.), Anon.

Beg. madiyahṛdayākāśe ... (1)
lāṭavaidhṛtam eṇṇunna prakāram atha collinen /
ayanāṁśam iraṭṭicciṭṭarkanil saṁskariccatu //

Ms. 1005-D (inc., 160 gr.)

Pañcabodha X, *Pañcabodhagaṇitam Bhāṣā* (kar.), (Mal.), by Kṛṣṇadāsa (Koccu-Kṛṣṇan Āśān). Mss. PM. 4111-A, PM. 4155-B. Ref. Ul. III. 524.

Pañcabodha XI (kar.), unidentified.

Do.—C (Mal.), by Vāsuṇṇi Mūssatu of Veḷḷānaśśeri. Men. Ul. IV. 700.

Pañcabodhakriyākrama by Śaṅkaran Nampūtiri: See C on *Pañcabodha* II.

Do.—Anon.: See C IV on *Pañcabodha* IV.

Pañcabodha-Gaṇitasāra (kar.), (Mal.), by Śaṅkaran Nampūtiri of Mahiśamaṅgalam: See *Gaṇitasāra* II.

Pañcabodhaśataka by Puruṣottama: See *Pañcabodha* V.

Pañcbodhārtha-darpaṇam: See C III on *Pañcabodha* IV.

Pañcamahāyoga (astrol.), (Skt.-Astrol.), Anon. Ms. L. 740-C.

Pañcāṅga (almanac), (Mal.), Anon. Mss. 5779 (for M.E. 1011-60), 5841 (for M.E. 1061-80), 6010-A (for M.E. 1000-25).

Pañcāṅga (muhūrta), for 1000 years, attributed to Śaṅkaran Nampūtiri of Mahiṣamaṅgalam. Ref. Ul. II. 272.

Pañcāṅga: See also *Agaṇita*.

Pañcāṅgagaṇanaviṣaya (kar.), (Mal.), Anon. Ms. in Mad. D. 13454.

Pañcāṅgagaṇita (kar.), (Mal. verse), Anon. Ms. 8268-C (220 gr.).

Pañcāṅgaphalam (astrol.), (Mal. verse), Anon. Mss. 6478-D, 12564-B, 13215-H, L. 144-G.

Pañcāṅgaphalam : See also *Vāradiphalanirṇaya.*

[*Pañcāṅgavākya* (kar.),] -C (Mal.), Anon. Ms. Mad. D. 13454.

Paddhatigaṇitakriyā (kar.), (Mal. prose), Anon. 400 gr. Ms. 5074-B. **Rem.** Of which *Paddhati* this is a *gaṇitakriyā* remains to be ascertained.

Panakkāṭṭu or Iṭakkāṭṭu Nampūtiri, (*c.* 1615-95), son of Mahādeva and Śrī, pupil of Dāmodaran Nampūtiri of Maṅgalaśśeri family.

—*Gaṇitagrantha*

—*Praśnamārga*

—C *Durgamārthapradarśinī* on his own *Praśnamārga*

Ref. *Ker. Astron.* pp. 66-67, § 45 ; Ul. III. 87-89 ; Va. III. 400-5.

Parameśvara I : Parameśvaran Nampūtiri, (*c.* 1360-1455), of Vaṭaśreṇi (Mal. Vaṭaśśeri) house in the Aśvattha-grāma (Mal. Ālattūr), pupil of Mādhava, Nārāyaṇa and Rudra.

—*Ācārasaṅgraha* I

—*Goladīpikā* I

— Do. II

— Do. III

—*Grahaṇanyāyadīpikā*

—*Grahaṇamaṇḍana*

—*Grahaṇāṣṭaka*

—*Candracchāyāgaṇita*

—*Jātakapaddhati*

—*Dṛggaṇita*

—*Vākyakaraṇa*

—*Vivāhānukūlyam*

—*Ṣaḍvargaphalam*

—C *Bhaṭadīpikā* on the *Āryabhaṭīya*

—C *Vivṛti* on his own *Goladīpikā* I

—C on the *Jātakakarmapaddhati* of Śrīpati

—C *Parameśvarī* I on the *Praśnaṣaṭpañcāśikā* of Pṛthuyaśas

Parameśvara I (contd.)

—C *Karmadīpikā* on the *Mahābhāskarīya* of Bhāskara I

—C *Siddhāntadīpikā* on the *Mahābhāskarīya-bhāṣya* of Govindasvāmin

—C on the *Muhūrtaratna* of Govinda Bhaṭṭatiri

—C *Pārameśvara* on the *Laghubhāskarīya* of Bhāskara I

—C *Pārameśvara* on the *Laghumānasa* of Muñjāla

—C *Vivaraṇa* on the *Līlāvatī* of Bhāskara II

—C on the anon. *Vyatīpātāṣṭaka*

—C *Vivaraṇa* on the *Sūryasiddhānta*

—C *Dīpikā* on the anon. *Muhūrtāṣṭaka*

—C *Bhādīpikā* on an unidentified work

—C *Vākyadīpikā* on an unidentified work

Ref. *Ker. Astron.*, pp. 2ff., 19-20; 52-54, § 23; K.V. Sarma, Intro. to his edns. of P's works ; Raja, 136-43 ; Sen, pp. 166-70 ; UI. II. 100-5 ; UI. Sup. I. 212-19 ; Va I. 378-83.

Parameśvara II

—C *Pārameśvarī* (II) on the *Praśnaṣaṭpañcāśikā* of Pṛthuyaśas.

—C *Pārameśvarī* or *Horābhiprāyanirṇayā* on the *Horā*.

Ref. *Ker. Astron.*, p. 73, § 61.

Parameśvara III, disciple of Śaṅkara.

—C *Jātakacandrikā* or *Viśvārthadīpinī* on the *Horā*

Ref. *Ker. Astron.*, p. 73, § 62.

Parameśvara IV : Parameśvaran Nampūtiri of Puradahanapura (Mal. Purayannūr) family, c. 1775-1839; pupil of Agnidattan Nampūtiri.

—*Aṣṭamījayantīnirṇaya*.

—C *Varadīpikā* on *Muhūrtapadavī* II.

Ref. *Ker. Astron.*, pp. 76-77, § 72; UI. III. 476-77; Va. II. 605-12.

Parameśvara V : Parameśvaran Poṯṯi of Vazhamāveli house in Chengannoor; renowned astronomer-astrologer and teacher of the prolific writer Śaṅkaran Nampūtiri of Mahiṣamaṅgalam.

Ref. *Ker. Astron.*, pp. 62-63, § 37; p. 64, § 38.

Parameśvara VI, (c. 1775-1825), astronomer; teacher of Ghaṭīgopa.

Ref. *Ker. Astron.*, p. 77, § 74.

Paralperu (arith.), Skt.-Mal., Anon. Ms. C. 13-B (65 gr.)

Parahitam or *Grahacāranibandhanam* : See *Grahacāranibandhanam*.

Parahitakaraṇam (kar.), Anon. Ms. 5820 C.

Do.—C (Mal.), Anon. Ms. 5820-C.

Parahitakhaṇḍaḥ (kar.), Anon. Ms. 11044-S (6 gr.; M.E. 948).

Parahitagaṇitam (kar.), Anon. Ms. 411-B-1 13300-F, L. 1248-I.

Parahitavyākhyāgaṇita (kar.), Anon. Mss. Ad.; Sarasvati Mahal Library, Tanjore.

Parahitādijyāḥ (kar.), Anon. Ms. L. 1076-B.

[*Parāśarahorā* (astrol.)]

—C *Prakaṭārtha* or *Sampradāyapradīpikā* by Govindasvāmin.

Mss. Sarasvati Mahal Library, Tanjore, D. 11498, D. 11499; Or. Res. Inst., Mysore, 3166.

Paliśa-ślokaṅṅal (calculation of interest), by Putumana Somayāji.

Mss. C. 2314 (folio 74), C. 2470 (folio 98).

Pāṭu gaṇippan Bhāṣā : See C (Mal.) on *Vyatīpātavaidhṛta*.

Pāṭum piṟappum (kar.), Mal. verse, Anon., 20 gr. Ms. L. 251-B.

Pāṭhya : Name of anon. C on *Horā*.

Putumana Somayāji (c. 1660-1740), native Śivapura (Trichur).

—*Karaṇapaddhati*

—*Gaṇitagrantha*

—*Grahaṇagaṇita* I

—*Grahaṇāṣṭaka* II

—*Jātakādeśamārga* I

— Do II

—*Nyāyaratna* I

— Do. II

—*Pañcabodha* III

Putumana Somayāji (contd.)

—*Paliśa-ślokaṅṅal* (Mal.)

—*Veṇvārohāṣṭaka*

—C (Mal.) on the *Laghumānasa* of Muñjāla

Ref. *Ker.Astron.* pp. 68-69, § 49; K.V. Sarma, 'P, an astronomer of Kerala and his hitherto unknown works', *Proc. of the 18th All-India Or. Conf., Annamalainagar, 1955*, pp. 562-64. Intro. to *Karaṇapaddhati*, (Madras, 1956), pp. xxi-xxxi ; Raja, 162-65 ; Ul. II. 107-9 ; Ul. Sup. I. 212-15 ; Va. I. 529-31.

Purayannūr Nampūtiri : See Parmeśvara IV.

Puruṣottama I, Māttūr Nampūiri, *c.* 1475-1535.

—*Muhūrtapadavī* II

Ref. *Ker. Astron.*, pp. 61-62, § 34.

Puruṣottama II, *c.* 1675-1750.

—*Pañcabodha* IV or *Pañcabodhaśataka*

Ref. *Ker. Astron.*, pp. 67-68, § 48.

Puruṣottama III : Puruṣottaman Mūssatu, (*c.* 1850-1900), of Kūttaleṭattu family, pupil of Bhāskara, Śaṅkara, Vahni and Nārāyaṇa, and grand-disciple of the au. of *Praśnamārga*.

—*Praśnāyana*

—C on his own *Praśnāyana*

Ref. *Ker. Astron.*, pp. 79-80, § 79.

Pulimukhattu Poṭṭi (1686-1758), astrological authority.

Ref. *Ker. Astron.*, p. 5.

Pūrṇaprajña- or Pūrṇaprabodha- Śiṣya,

—*Kālaprakāśikā*

— C (*X*) (Mal.) on *Horā*

Poruttam I (astrol.), Anon.

Beg. yadyatphalam narabhave kṣamam aṅganānām
tattad vadet patiṣu vā sakalam vidheyam /
teṣām tu bhartṛmaraṇam nidhane vapuś ca
lagnendugam subhagatāstamaye patiś ca //

Ms. CM. 6-B.

Do.—C (Mal.). **Beg.** itinnupadeśamāvatu— yadyat yātorikkal.

Ms. CM. 6-B.

Poruttam II (astrol.), Mal.-Skt., 100 gr.

Beg. jāto janmatrayāt strīṇām vipat pratyaranaidhane (?) /
varjyo'trāpi viśeśeṇa kuvedāgnyaṁśajaḥ kramāt //

Ms. CM. 173-B.

Poruttam cārttum prakāram (?) (astrol.), (Mal.), Anon.

Beg. naṭe rāśipporuttatte nirūpikka—
strījanmato raṇṭatha mūnnum añcum /
āṟum vivarjjikka śubho'nyarāśau //

Ms. CM. 4147-D.

Prakaṭārtha : Name of C by Govindasvāmin on *Parāśarahorā*.

Prakāśalatikā or *Dviśatī* : See *Dviśatī*.

Prakāśikā : Name of C by Nityaprakāśa Yati on *Horā*.

Prakīrṇasaṅgraha (kar.) : Same as *Pañcabodha* I, with certain differences. Mss. See *Ker.*, II. p. 156. Ref. Va. III. 390-96.

Prathamārtavādiphalam (astrol.), Mal. prose, Anon. Ms. 5820-D.

Praśnacintā (pra.), Anon., Skt.-Mal.

Beg. ravyuccāsṛktamomandacandrajñaguravaḥ kramāt /
prāgādyaṣṭamadiksthānāt prārabdhārkodayāditaḥ //
......santatipraśnam nirūpippān...

Ms. T. 144-D (b)

Praśnajñānam or *Praścalāñchanam* : See *Praśnalāñchanam*.

Praśnapaddhati (pra.), Anon. Ms. Vayaskara Illam, Kottayam, 92-A.

Praśnaprakāśikā I (pra.), Mal. prose-verse, Anon., in 7 chs., 1150 gr.

Beg. vande'ham girijāsūnum jñānamūrtim gurūn grahān /
Praśnaprakāśikām vakṣye bālakānam hitāya vai //

Mss. C. 554, T. 326. Ref. Ul. III. 242.

Praśnaprakāśikā II (pra.), Mal. prose, Anon. Ms. 3383-F.

Praśnaphalam I (pra.), Mal. prose, Anon. Ms. T. 144-B.

Praśnaphalam II (pra.), Mal. verse, Anon. Ms. 3383-B.

Praśnaphalaprāptikālanirṇaya (pra.), by a disciple of Kṛṣṇa.

Beg. Kṛṣṇācāryamatam samyak paryālocya punaḥ punāḥ / praṣṭuḥ praśnānusāreṇa phalam vācyam vipaścitā // atha *Praśnaphalaprāpteḥ* kathyate *Kālanirṇayaḥ* /

End : Kṛṣṇācāryasya śiṣyeṇa Horāṇām upapāditā / Kṛṣṇacāryaprasādena prasādāc ca vivasvataḥ // Kṛṣṇācāryopadiṣṭārthaḥ yeṣām manasi vartate / avyāhatamatis teṣām phalabhāge pravartate //

Ms. Ms. D. 13950.

Praśna-Bhāṣā I (pra.), Mal. verse, Anon.

Beg. mattebhāsyam praṇamyādau bhāskarādīn grahān gurūn / *Praśnabhāṣām* pravakṣyāmi bālānam aṟivān aham //

Mss. See *Ker. Mal.*, pp. 89-90 ; CM. 563-F, PM. 4026-E. Edn. *Śrī Vanchi Setu Lakshmi Series*, No. 4, Trivandrum, 1926. Ref. Va. III. 383.

Praśna-Bhāṣā II (pra.), Skt.-Mal., Anon. Mss. 3671-E, 5095-B, 5780-A.

Praśnamārga I (pra.), by a member of the Panakkāṭṭu or Iṭakkāṭṭu Nampūtiri family, (c. A.D. 1650), in 32 chs., 400 gr.

Mss. See *Ker.*, II. pp. 177-78. Edn. Punnaśśeri Nīlakaṇṭha Śarmā, Trichur, M.E. 1104. Ref. Ul. III. 87-89 ; Va. III. 400-5.

Do.—C. I, *Durgamārthaprakāśinī*, by the author himself. Mss. Ker. II. p. 178. Ref. Ul. III. 89 ; Va. III. 400-5.

Do.—C II (Mal.), Anon.

Beg. ...vedattinṟe cakṣussallo i śāstramākunnatu. atukoṇṭu aṅgaṅṅaḷil i śāstram pradhānam ennu vannū.

Ref. Va. III. 405.

Do.—C III (Mal.), by Āzhvāñceri Tamprākkaḷ, included in his *Phalasārasamuccaya* (*Praśnabhāga.*).

Do.—C IV (Mal. rendering), being chs. I-XII of the *Praśnarīti* of Iṭakkaṭṭu Kukkaṇiyāḷ.

Praśnamārga II (pra.), Mal. prose, Anon. Ms. L. 1100-B.

Praśnamārga III (pra.), Mal. verse, Anon., 1000 gr. Ms. T. 155.

Praśnamārga : See also *Laghu-Praśnamārga.*

Praśnamālā (pra.), Anon., by Śaṅkara of Mahiṣamaṅgalam.
Beg. vande girīśam girijāsametam... (1) ;
praṣṭuḥ svabhāvekṣaṇaveṣabhāṣā... (2)
Ms. TM. 213.

Do —C (Mal.), Anon., possibly by the author himself.
Beg. jātakaśāraṅṅaḷilum praśnasāraṅṅaḷilum bhūtalakṣaṇam nimittam...
Ms. TM. 213. **Ref.** Ul. III. 242. **Rem.** The Skt. text and the Mal. C have only a common *maṅgaḷa-śloka.*

Praśnaratna (pra.), Anon., 350 gr., (Ker. ?)
Beg. yatsvātantryakalākālaścillavo jyotiṣām gaṇaḥ /
candrapūṣamadaḥ pūrṇacidānandam aham śraye //
Mss. *Ker.*, II. p. 179.

Praśnarīti I (pra.), by Dāmodaran Nampūtiri of the Maṅgalaśśeri house.
Ref. Va. III. 379.

Praśnarīti II (pra.), (Mal. verse), by Iṭakkāṭṭu Kukkaṇiyāḷ, 17th cent., in 20 chs. **Mss.** See *Ker. Mal.*, p. 90. **Edn.** in the Mal. monthly *Kavanodayam,* (Kozhikode). **Ref.** Ul. III. 236-37 ; Ul. Sup. I. 536 ; Va. III. 405-6.

Praśnalakṣaṇam I (pra.), Skt.-Mal., Anon. **Ms.** 13494-F.

Praśnalakṣaṇam II (pra.), Mal. prose. Anon. **Ms.** 13042-D

Praśnalakṣaṇam III (pra.), Mal. prose, Anon. **Ms.** L. 331.

Praśnalāñchanam or *Praśnajñānam* (pra.), Skt.-Mal., Anon., 294 vv.
Beg. ravicandrabhaumasomajasuraguruśukrārkajādikān natvā /
vakṣye *Lāñchanarūpam Praśnajñānam* hitāya daivavidām //
Mss. 6007-G, 14294-N, L. 327-D. **Ref.** Va. III. 387-88.

[*Praśnaṣaṭpañcāśikā* (pra.), by Pṛthuyaśas].
Do.—C I, *Pārameśvarī,* by Parameśvara I, 300 gr.
Beg. namaskṛtya gaṇeśānam... (1) ; tatra prathamam kendracatuṣkasya saṅkṣepād viṣayabhedān āha.
Mss. 5963, 12235, C. 2132-B, T. 612.

Praśnaṣaṭpañcāśika (contd.)

Do.—C II, *Pārameśvarī*, by Parameśvara II, 330 gr.

Beg. keśajārkaniśākarān kṣitijavijjīvāpnujitsūryajān ...
lokānam hitakāmyayā dvijavaraṣ ṭikām karoty ujjvalām //

Mss. C. 652-A, T. 962.

Praśnasaṅgraha, *Praśnasārasaṅgraha* or *Sārasaṅgraha* (pra.), Anon.

Beg. sūryendvagnivilocanam ... Cellūranātham śivam (1) ;
Madhyāṭavyadhipam praṇamya kamalam ... (2) ;
skandheṣu triṣu saśramaḥ kṛtamanāḥ ... (3)

Ms. Whish, 144 (1).

Praśnasāra I (pra.), by Mādhava of Iñcakkazhvā family, in 16 chs., 960 gr., A.D. 1543. **Mss.** C. 2139-B, C. 2478-A. **Edn.** *Sri Vanchi Setu Lakshmi Series*, No. 11, Trivandrum. **Ref.** Ul. II. 475-77.

Praśnasāra II (pra.), by Śaṅkara, in 4 chs. (Skt.-Mal.)

Beg. daivajñopahito'tha deśasamayau ...

Mss. 10582-A, CM. 565-F, PM. 4168.

Do.—C (Mal.), Anon., possibly by the author himself. **Mss.** 10582-A, CM. 565-F, PM. 4168.

Praśnasāra III (pra.), by a Somayāji of Bhūtanāthapura, pupil of Vaidyanātha. **Mss.** 2745, 12810-A, C. 2007-D, T. 876.

Praśnasārasaṅgraha : See *Praśnasaṅgraha*.

Praśnasārasamuccaya (pra.), Anon.

Beg. praṇipatya gaṇeśānam jñānamūrtim divākaram /
*Praśna*śāstram samālokya vakṣye *Sārasamuccayam* //

Mss. P. 896, P. 897, P. 898.

Do.—C (Mal.), Anon.

Beg. praṇipatya ... ennatin poruḷ—aham gaṇeṣānam praṇipatya Sārasamuccayam vakṣye.

Ms. P. 898.

Praśnadarśa or *Jñānapradīpikā* : See *Jñānapradīpikā*.

Praśnānuṣṭhānam (pra.) Anon.

Beg. padabhāvaguṇā senā ramyaghnā hīnabhā dalā /

Ms. CM. 543-A.

Do.—C (Mal.), Anon. Ms. CM. 543-A.

Praśnānuṣṭhānapaddhati I (pra.), Anon., probably by Śaṅkara of the next entry, 720 gr.

Beg. astu trailokyadīpāya bhaktābhimatadāyine /
samastavidyānirmāṇakavaye ravaye namaḥ //
svasthacitto viviktasthaḥ samabhyarcya gaṇādhipam /
nijān gurūn devatāś ca sūryādīṁś ca navagrahān //

Mss. 722-A, 10582-B, C. 632-C, C. 733-B, TM. 36. Ref. Ul. Sup. I. 223-24.

Praśnānuṣṭhānapaddhati II (pra.) by Śaṅkara, in 24 chs., Possibly, an enlarged version of the previous work, *Praśn*° I. 1550 gr.

Beg. astu trailokyadīpāya (as above) (1) ;
prātarvidhim vidhivad eva vidhāya pūrvam
kṛtvā punar japavidhim gaṇanam grahāṇām /

Mss. 4162-A, 6121-B, 6126, C. 962-C, C. 2066-A, L. 839, P. 899, P. 900. T. 36. Ref. Ul. Sup. I. 223 ; Va. III. 386-87.

Praśnāmṛta (pra.), by Śrīkumāra, son of Nīlakaṇṭha and pupil of Nārāyaṇa, of the village of Dvipakānana (? Mal. Ānakkāḍ), in 6 chs., 400 gr. Mss. 1154 C, 3671-C; Whish 118 (2).

Praśnāyana (pra.), by Puruṣottaman Mūssatu, in 15 sns., A.D. 1881. Mss. 15084, T. 955. Edn. *TSS* 233 (with C), Trivandrum, 1968. Ref. Ul. Sup. I. 225.

Do.—C, by the author himself. Mss. C. 721, T. 955. Edn. *TSS* 223, above. Ref. Ul. Sup. I. 225.

Praśnārūḍhādinirūpaṇam (pra.), Mal. prose, Anon. Ms. 13294-B.

Praśnopadeśa I (pra.), Old Mal. prose, Anon.

Beg. rogapraśnamāvitu—guḷikane vaccu...

Ms. PM. 4169 (412 gr.)

Praśnopadeśa II (pra.), Mal. prose, Anon. Ms. 14218-B.

Prasavādipraśnaphalam (pra.), Mal. prose, Anon., Ms. L. 336. E.

[*Phaladīpikā* (astrol.) by Mantreśvara :] C (Mal.), Anon. Ms. C. 2226 B.

Phalanirṇaya (astrol.) : See *Vārādiphalanirṇayaḥ*.

Phalasārasamuccaya (astrol.), by Āzhvāñceri Tamprākkaḷ. Ms. L. 1249-A (inc., 150 gr.), in three sections devoted to *Jātaka*, *Praśna* and *Muhūrta*.

Do.—C (Mal.), *Bhāṣā*, by the author himself. Mss. *Jātaka* sn. : L. 1215, T. 132-A, (9000 gr.) ; *Praśna* sn. : C. 198, L. 1216, L. 1350-A, (5000 gr.) ; *Muhūrta* sn. : T. 132 B, C, (7000 gr.)

Bālabodhinī or *Bālaprabodhinī* : Name of anon. C on the *Jātakapaddhati* of Parameśvara.

Bālarāman Piḷḷa (19th cent.), of Nālekāṭṭil family, astrological authority. **Ref.** See above, p. 5.

[*Bṛhajjātaka* (j.) by Varāhamihira : See *Horā*].

Bhagaṇahārakādivākya (kar.), Mal. prose, Anon. Ms. 13230-A.

Bhadradīpagaṇita (kar.), (Mal.), by Iṭakramañceri Nampūtiri, in 11 chs., *c.* A.D. 1665. Mss. See *Ker. Mal.*, p. 98. **Ref.** Ul. III. 232-34 ; Ul. Sup. I. 534-35.

Bhādīpikā (astron.), C (?) on an unidentified work by Parameśvara of Vaṭaśreṇi. Men. by him at the close of his C on the *Mahābhāskarīya*.

Bhāradvāja-dvija, (*c.* 1750-1850).

—*Karaṇadarpaṇa*

—*Gaṇitayuktayaḥ*

Ref. *Ker. Astron.*, pp. 73-74, § 63.

Bhāvacintāvalī (astrol.), by a pupil of Citrabhānu

Beg. natvā gaṇeśvaram vāṇīm *Citrabhānum* gurum grahān /
bhaktyā vilikhyate kiñcit *Bhāvacintāvalī* mayā //

Ref. Raja, 154 (°*cintāmaṇi*, wrongly) ; Ul. II. 275.

Bhāvavicāra (astrol.), Anon., Skt.-Mal. Ms. Vayaskara Illam, Kottayam, List, 107.

[*Bhavadhyāya* (astrol.) : **Beg.** mūrtyādayaḥ padārthāḥ...]

—C (Mal.) : **Beg.** yātoru śāstrattiṅkal nintu yātoru grahattekkoṇṭu mūrttyādikaḷāyirikkinta padārthaṅṅal...

Ms. PM. 4241. **Ref.** Ul. II. 263.

Bhāṣāgaṇitam (astron.), Mal. verse, Anon.

Beg. ādityan ādiyāyuḷḷa grahaṅṅaḷeyateṇṇuvān / bhāṣyāyiṭṭu collunnen atinuḷḷa kramaṅṅaḷe //

Ms. PM. 4368-E.

Bhāṣājyotiṣasaṅgraha : See *Jyotiṣasaṅgraha*.

Bhāṣāsaṅgraha : C by Vāsudeva on *Muhūrtapadavī* V.

Bhāskarīyagaṇita : Name of C XI on *Līlāvatī*.

Bhinnāṣṭavargopadeśa (astrol.), (Skt.-Mal.), Anon.

Beg. bhinnāṣṭavargopadeśam varutumāṟu collunnen ... nyūnam yatra phalam tena ...

Ms. CM. 565-1.

Bhūgolanāyam (astron.), (Mal.), by Iṭakramañceri Nampūtiri (?), 85 gr.

Beg. khamadhyato nilpitu bhūmi tanṭe
kakṣyāntare dhāraṇa koṇṭuṟaccu /
uruṇṭa nāraṅṅavad ākṛtim pūṇṭ-
'īśānati' (1050) yojanatulyamadhyā // ...
bhūgoḷattinu naṭuve melkizhāyuḷḷa cuṭṭilum
nālu pattanam uṇṭallo nālu dikkilum iṅṅine // ...
ākāśagoḷamadhyattil ghaṭikāmaṇḍalasthitḥ / ...
pādonaṣaṭkaramitam muḷayoṭṭu kīṟi
keṭṭiccamecc akalam ā(ṟ)api tōrayākki / ...
cemmeyuṇakkiy ivayokke varaṇṭu vannāl
keṭṭīṭṭu goḷavum uṭan kramam ottu pinne // ...
mūnnañcayampoṭu nūṟu raṇṭu kharago-
nakṣatrasaṅkhyāśvitaḥ /

Col. iti *Bhūgolanāyam*.

Ms. With K.V. Sarma.

Bhūtanāthapura Somayāji
—*Praśnasāra* III

Ref. See above, p. 76, § 68.

Bhūparīkṣā (nat. astrol.), Mal. prose, Anon. Ms. 13494-Q.

Bhūmipporuttam (astrol.), Mal. prose, Anon. Ms. 13020-F.

Bhṛgukerala : See *Śukrakerala*.

Bhojanādipraśnavicāra (pra.), Mal., Anon. Ms. 13494-N.

Maṅgalaśreṇivipra-Śiṣya (17th cent.)

—*Jyotiṣasaṅgraha* II (Mal.)

Ref. *Ker. Astron.*, p. 66, § 44.

Maṅgalaśśeri Nampūtiri : See Dāmodara II.

Maccāṭṭu Iḷayatu : See Nārāyaṇa VI.

Maccāṭṭu Bhāṣā : See *Jyotiṣabhāṣāvalī*.

Madhyamādigaṇitam (?) (kar.), Mal. Mss. See *Ker. Mal.*, p. 108.

Madhyamānayanagaṇitam (kar.), Skt.-Mal., Anon., 125 gr. Ms. 1025-G.

Madhyamānayanaprakāra (astron.), by Mādhava of Saṅgamagrāma. Qn. in *Tantrasaṅgrāha* of Nīlakaṇṭha Somayāji.

Do.—C, Anon.

Beg. 'vistṛti'-tyādi, 'arkendvor'-ityādi-anayor ślokayor yukti-pradarśanāya ...

Ms. IO 6301 (ff. 16-18).

Maraṇavākya (astrol.), Mal. prose, Anon. Ms. L. 1075-F.

Malamāsanirṇaya (astron.), Mal. prose, Anon. Ms. L. 1229-B.

Malamāsavicāra (astron.), Mal. prose, Anon., 50 gr. Ms. L. 1229-C.

Mahājyādyānayanam (?), (astron.), (Mal.). Ms. 13294-0 (350 gr.)

Mahāyānayanaprakāra (?) (astron.), by Mādhava of Saṅgama-grāma.

Do.—C, Anon.

Beg. 'nihatya cāpavargeṇa ... ', iṣṭacāpavargeṇa iṣṭacāpam, tat-phalāni ca nihatya ...

Ms. IO 6301 (ff. 12-16).

[*Mahabhaskarīyam* (astron.), by Bhāskara I]

Do.—C I, *Bhāṣya*, by Govindasvāmin. **Mss.** 5847, 12562-A, C. 1888-A. P. 903, P. 945, P. 977 (on ff. 59-98, not sep. catalogued), T. 844; Mad. R. 5138. **Edn.** by T. S. Kuppanna Sastri, *Madras Govt. Or. Ser.*, No. 130.

Do.—CC I, *Siddhāntadipikā*, by Parameśvara. **Mss.** 274, T. 931. **Edn.** With C, above.

Do.—CC II, by Sūryadeva Yajvan.

Ref. By Sūryadeva Yajvan himself towards the end of his C on *Laghumānasa* : "pūrvam mayā ... *Bhāskarācārya-Mahā-tantravivaraṇam Govindasvāmyam* prathamam vyākhyātam."

Do.—C II, *Karmadīpikā*, by Parameśvara.

Ms. Mad. R. 3842. **Edn** *Ānanadāśrama Skt. Ser.*, No. 126, Poona, 1945.

Do.—C III, *Prayogaracanā*, Anon.

Beg. praṇamata śivam aniśam ... (1); kriyate *Prayogaracanā* ... (2); akṣarasaṁjñā jñeyā ... (3). kalām bibhartīti devatā-namaskāraḥ.

Mss. 8933-A, C. 166-I, C 2121-B, T. 176; Mad. R. 3034.

Mahamārganibandhanam (astron.), by Haridatta. Basic text of the Parahita system of Kerala astronomy. **Men.** In the au's. *Grahacāranibandhana*, III. 44.

[*Mahayātrā* (astrol.), by Varāhamihira]

—C by Sūryadeva Yajvan

Men. By Sūryadeva Yajvan himself at the close of in his C on *Laghumānasa* : "mayā...tato *Varāhamihirakṛtā Mahāyātrā* saṅkṣepeṇa vyākhyātā."

Mahiṣamaṅgalam Nāmpūtiri : See Śaṅkara III.

Māttur Nampūtiri-s of Pāñcāla-grāma (Mal. Pāññāḷ), *c.* 1475-1535.

—*Muhūrtapadavī* II, by Puruṣottama

—*Muhūrtapadavī* III, by Subrahmaṇya

Ref. *Ker. Astron.*, pp. 61-62, § 34. See also Ul. II, 109-11 and Va. II. 601-2, where the two authors are not identified.

Mādhava : See also Vidyāmādhava.

Mādhava I, (*c.* 1340-1425), of Saṅgamagrāma near Cochin, teacher of Parameśvara of Vaṭaśreṇi.

—*Golavāda*

—*Madhyamānayanaprakāra*

—*Mahājyānayanaprakāra*

—*Lagnaprakaraṇa*

—*Veṇvāroha*

—*Śīlam rājñaḥ śrīyetyādi-viliptādivākyāni*

Ref. *Ker. Astron.*, pp. 16ff. ; 51-52, § 22 ; K.V. Sarma, Intro. to his edn. of *Veṇvāroha*, pp. 5-10 ; Raja, 133-36 ; Ul. II. 98-100 ; Va. I. 387-88 ; III. 388-90.

Mādhava II, of Iñcakkāzhvā, 16th cent., pupil of Govindamaṅgalam Nampi.

—*Praśnasāra* I (Mal.)

Ref. *Ker. Astron.*, p. 64, § 38 ; Ul. II. 475-77.

Mānasagaṇitam (astron), by Putumana Somayāji. Possibly, same as the C III (Mal.). *Mānasocitam*, on *Laghumānasa*, noticed below. Men. K. Rama Varma Raja, 'The brahmins of Malabar', *Jl. of the Royal As. Soc.* (1910), p. 635.

Mānasocitam or *Mānasam eṇṇum prakāram* : Name of C III (Mal.) by Putumana Somayāji (?) on the *Laghumānasa* of Muñjāla.

Mālinī-kṣipraprasna (pra.), Mal. prose, Anon. Ms. 14163-A.

[*Muṣṭipraśna* (pra.)]

Do.—C (Mal), 35 gr. Ms. 8358-C.

Muhūrtakālaprakāśika : See *Kālaprakāśika*.

Muhūrtam Bhāṣā I (Muh.), Mal. maṇipravāḷa verse, Anon.

Mss. See *Ker. Mal.*, p. 113.

Muhūrtam Bhāṣā II (muh.), Skt.-Mal., Anon. Ms. 5033-C.

Muhūrtam Bhāṣā III (muh.), Mal. prose, Anon. Ms. 6007-C.

Muhūrtakaumudī (muh.), Mal. verse, Anon. Mss. 8345, T. 1173.

Muhūrtadarśana (muh.), by Vidyāmādhava of Nīlamana, in 15 chs.

Mss. *See Ker.*, II. pp. 313-14 ; Ad. ; Mad. ; Mysore.

Edn. Or. Res. Inst., Mysore, 3 vols., 1923-26. **Ref.** Ul. II.95 ; Va. I. 443-44.

Do.—C I, *Dīpikā*, by Viṣṇu, the author's son. Mss. C. 139, C. 337, C. 2200, T. 225. **Edn.** With the text, above.

Do.—C II, *Bhāvaprakāśa*, by Subrahmaṇya, 3300 gr. **Ms.** 8355. **Ref.** Ul. Sup. I. 540 ; Va. I. 444.

Do.—C III (Mal.), Anon.

Beg. śriyam śrīgurupādābjapāṁsavaḥ pradiśanti vaḥ /
bhavanti bhavarāśer ye sukhottarahetavaḥ //

iti. *Muhūrttadarśanamākunna* prakaraṇatte camappān tuṭaṅṅunna ācāryan atinṭe ... 'jayatyameya' (text) iti. savitā jayati—oṭṭozhiyāte uḷḷa lokaṅṅaḷuṭe prasūtikāraṇamāyuḷḷa ādityan ...

Mss. 420, 3761-A, 5853, 6043, 10921, 11083, C. 564. C. 2138, C. 2140, C. 2515-A, T. 277.

Do.—C IV (Mal.), Anon.

Beg. jayatyameyāṁśu (etc.), (text). savitā jayati—ādityan yallāyilum mel varttikkunnon. ellārakkāṭṭil prādhānyam entenneṭattu collunnū.

Mss. CM. 564, P. 910.

Do.—C V (Mal.), Anon. **Mss.** 284, 621-B, 11010-A, T. 152.

Do.—C VI (Mal.), by Āzhvāñceri Tamprākkaḷ, incorporated in his *Phalasārasamuccaya* (*Muhūrta* section).

Do.—C VII (Mal.), Anon., unidentified. **Ms.** Mad. D. 13594 (ch. II, inc.)

Muhūrtadīpaka (muh.), by Nārāyaṇa, son of Keśava of Kāṇvavastu.

Mss. 1055-B, 5835-A, P. 911, P. 912. **Ref.** Ul. II. 107 ; Va. II. 612-13.

Muhūrtanirṇaya (muh.), (Mal.), Anon. **Mss.** T. 144-A, B.

Muhūrtapadavī I (muh.), ascribed to Govinda Bhaṭṭatiri of Talakkuḷam. **Qn.** In C, *Varadīpikā*, by Parameśvara IV on *Muhūrtapadavī* II. **Ref.** Ul. II. 110.

Muhūrtapadavī II (muh.), by Puruṣottama of the Māttūr Nampūtiri family from Pañcalagrāma (Mal. Paññāḷ), in 36 verses.

Beg. pratyūhapraṇihantāram praṇipatya gaṇādhipam /
muhūrtāvagame mārgam ṛjum kartum yatāmahe //1//
ulkorvīcalanoparāgaguḷikāḥ (etc.) //2//

End : V(B)ṛhadāvṛti-gehasambhavena
dvijarājñā *Puruṣottamā*bhidhena /
gurunāthakṛpābalāt kṛtam yat
tad idam sadviduṣām mude'stu nityam // (Ms. IO 8070)

Mss. See *Ker.*, II. pp. 315-18 ; P. 914 ; IO 8070 ; Ad. Edn. C. K. Vasudeva Sarma, Kozhikode, 1952. **Ref.** Ul. I. 110-11 ; Va. II.602-12. **Authorship.** See *Ker. Astron.*, p. 61.

Do.—C I, *Dīpa* or *Muhūrtasaraṇī-dīpa*, Anon.

Beg. namāmi vighnarājam tam vighnarājanivṛttaye / ... (1)
Muhūrtasaraṇī-dīpam sarvasaṁśayanāśanam /
vyākhyānam likhitum yatnam karomi janarañjanam //
(text) ulketyādi...

Mss. 3172-A, 3567, 3577-E, C. 1023-C. **Ref.** Ul. II.111.

Do.—C II, *Varadīpikā*, by Parameśvara IV, of Puradahanapura (Mal. Purayannūr), A.D. 1815, 2000 gr. **Mss.** 5880, 13481-B, L. 397, T. 33, TM. 234 ; Ad. Edn. Trichur. **Ref.** Ul. III. 476-77 ; Ul. Sup. I. 627 ; Va. II. 605-12.

Do.—C III, Anon.

Beg. ulkorvī (etc.) ulkā alātapatanam. urvīcalanam bhūmikampaḥ. etayor eko vā yasmin dine dṛśyate...

Ms. C. 1908-G.

Do.—C IV (Mal.), *Bālaśaṅkaram*, by Śaṅkaran Nampūtiri of Mahiṣamaṅgalam, A.D. 1540. **Mss.** See *Ker.*, II. p. 317 ; *Ker. Mal.*, p, 114. **Edn.** *Śrī Vanchi Setu Lakshmi Series*, No. 5, Trivandrum, 1926. **Ref.** Ul. II. 471. **Note.** Mss. 13329-A and L. 165-B contain more matter than in the edn. above.

Do.—C V (Mal.), by Citrabhānu-Śiṣyaḷ(?)

Beg. abhivādya gaṇādhyakṣam vāgdevīm ca gurūn grahān /
Muhūrtapadavīm eṣa bhāṣayā vyākaromy aham //

Muhūrtapadavī III, C V (contd.)

iti. Muhūrtapadaviyām granthatte camappaän tuṭaṅṅunna ācāryan...

Mss. P. 924, P. 925, P. 926. **Authorship.** Suggested on the basis of the characteristic *maṅgala-śloka.*

Do.—C VI (Mal.), *Tamprākkaḷ Bhāṣā*, by Āzhvāñceri Tamprākkaḷ. **Edn.** Trichur.

Muhūrtapadavī III (muh.), by Subrahmaṇya of the Māttūr family, in 44 verses, 100 gr.

Beg. pratyūhapraṇihantṛ kiñcana mahaḥ sañcintya bhāsām nidhim bhānum ca, kriyate *Muhūrtapadavī* saṅkṣiptaśāstrāntarā...(1)

doṣalakṣaṇabalābalādikam... (2)

Mss. P. 913, P. 215 to 22-A. **Ref.** Ul. II.110. **Authorship.** See *Ker. Astron.*, p. 61, and C I, below.

Do.—C I (Mal.), Anon.

Beg. 'vṛddhimdheyāddhitāyā'sau...padyair iyam kṛtā

Muhūrtapadavī yena *Subrahmaṇyam* praṇaumi tam //1//

Mss. 12576, L. 865, L 1103-A, L. 5352-C ; Āzhvāñceri List, 81. **Note.** The gap in the above verse should have contained two letters, like *vagha* (°yāsā'vagha'°) denoting 44, being the number of verses in the work.

Do.—C II (Mal.), Anon.

Beg. aham kiñcana mahaḥ bhāsām nidhim bhānum ca sañcintya *Muhūrtapadavī* kriyate ity anvayaḥ.

Ms. PM. 4260-A.

Muhūrtapadavī IV (muh.), Anon., in 32 verses. **Ref.** Ul. II. 110.

Muhūrtapadavī V (?) (muh.), Anon.

Beg. cakrārdham mṛtivaidhṛtam ca guḷikaḥ
sandhyāhimastam viṣam
gaṇḍāntam navadoṣaketujananam
sāyāhnam ekārgaḷam /
saṅkrāntigrahaṇañ ca dagdham aśanir
vṛṣṭyulkabhūkampanam
ṣaḍḍoṣam bahulañ ca yāmyam ayanam
coṣṇañ ca śukrekṣaṇam //

Muhūrtapadavī V (contd.)

Mss. P. 894-C (cata. as *Jātakasāra-Keraḷabhāṣā*), P. 947-B (cata. as *Bhāṣāsaṅgraha*).

Do.—C (Mal. verse), *Bhāṣāsaṅgraha*, by Vāsudeva of Vaḷḷimana, in two versions of 178 or 185 verses, respectively.

Beg. jyotiśśreṣṭham aham vande sahasrakiraṇam ravim /
dineśam amarastutyam jaga- (broken) //
tumpayum tiṅkaḷum cūṭintappanṟe mumpile makan /
mamānamukamuḷḷappan akalappōkkukāpadaḥ //
vakṣye namaskariccittu vijñātum bhūtanāthane /
bālānam pozhutum mātram *Bhāṣāsaṅgraham* ity aham //

(text) : cakrārdham etc.

Mss. Version I in 178 verses : 13479-Q; version II in 185 verses : P. 894-C (cata. as *Jātakasāra-Keraḷabhāṣā*), P. 947-B (cata. as *Bhāṣāsaṅgraha*), T. 153. **Note** : Ul. (II. 270, 473) takes this as an independent work on *muhūrta* by Śaṅkaran Nampūriti of Mahiṣamaṅgalam.

Muhūrtapadavī VI (muh.), by Tuppan Nampūtiri of Iṭavaṭṭikkāṭṭu family, in 40½ verses. **Ref.** Ul. III. 475-76.

Muhūrtapadavī VII (muh.), by Nārāyaṇan Nampūtiri of Iṭavaṭṭikkāṭṭu family, in 36 verses. **Ref.** Ul. II. 475-76.

Muhūrtapaddhati (muh.), Anon., (Ker. ?). Ms. 14045-B.

Muhūrtam Bhāṣā, *Muhūrtavidhi* or *Tāmaranallūr Bhāṣā* (muh.), (Old Mal.), by a member of the Tāmaranallūr family and protégé of Ceyyūr (? Cellūr) Nārāyaṇan Nampūtiri, 300 gr.
Mss. 151-B, 515-A, 5835-C, 5839, PM. 4113-B, PM. 4147-A, (the last two cata. as *Muhūrtapadavī-Bhāṣā*). **Ref.** Ul. I. 400-1 ; Ul. Sup. I.146 ; Va. III.396.

Muhūrtamādhavīya : See *Muhūrtadarśana*.

Muhūrtaratna (muh.) by Govinda, in 4 chs. **Mss.** See *Ker.*, II. p. 318 ; Mad. **Ref.** Va. II. 499-500.

Do.—C by Parameśvara of Vaṭaśreṇi. **Mss.** 5853-B, C. 138, T. 144 A-B.

Ref. Va. II. 500, where it is wrongly stated that the author is different from P of Vaṭaśreṇi.

Muhūrtalakṣaṇam I (muh.), Anon. Ms. 865-B.

Muhūrtalakṣaṇam II (muh.), Mal. prose, Anon., Ms. T. 144-C-4.

Muhūrtalīñchanam (muh.), Mal. prose, Anon., 100 gr. Mss. 1134-D, L. 1352-E.

Muhūrtavicāra (muh.), Mal. prose, Anon. Ms. L. 899-A.

Muhūrtavidhi I (muh.), Mal. prose, Anon. Ms. L. 139-B.

Muhūrtavidhi II (muh.), Mal. verse, Anon. Ms. L. 398.

Muhūrtavidhi : See also *Muhūrtam Bhāṣā*.

Muhūrtābharaṇa (muh.), by Dāmodara of the Bhāradvāja gotra, in 9 chs., 1000 gr. Mss. T. 240, TM. 71. Ref. Ul. II. 105-6; Ul. Sup. I. 210-11.

Muhūrtaṣṭaka (muh.), Anon., 20 gr.

Beg. Jyeṣṭhāśleṣāgnirakṣohara (etc.)

Mss. 1055-H, P. 865, P. 866.

Do.—C I, *Ācāradīpikā*, in verse, by Ravi, 130 gr.

Mss. See *Ker.*, II, p. 319; P. 865, P. 866. **Ref.** Ul. II. 113-14.

Do.—C II, *Dīpikā*, by Parameśvara of Vaṭaśreṇi.

Men. By him at the close of his C on the *Mahābhāskarīya*.

Mauḍhyādigaṇitam (?) (kar.), (Mal.) Mss. *Ker. Mal.*, pp. 116-17.

Yātrāphalam (astrol.), Mal. verse, Anon., 20 gr. Ms. 5038-D.

Yātrāmuhūrta (muh.), Mal. prose, Anon., Ms. 10752-P.

Yuktibhāṣā or *Gaṇitanyāyasaṅgraha* (math.-astron. rationale), by Jyeṣṭhadeva, in two parts : Pt. I. Mathematics and Pt. II. Astronomy. 5350 gr. Mss. See *Ker. Mal.*, p. 48 (cata, *Gaṇitanyāyasaṅgraha*), p. 117. **Edn. with Notes** by Rama Varma Maru Thampuran and A. R. Akhileswara Ayyar, Trichur, 1948; (Pt. I only); **With Notes**, K.V. Sarma (Pt. II only) ; Gov. Or. Mss. Library, Madras, 1954. **Skt version** : See *Gaṇityukti*, Mad. R. 4382. **Ref.** Raja, 157-58 ; Sen, p. 73 ; Ul. III. 439-40 ; Ul. Sup. I. 612-16.

Yogaphala (astrol.), Mal. prose, Anon. **Ms.** 13494-J.

Yogādiphalam (astrol.), Mal. prose, Anon. **Ms.** 5109-G.

Yogyādividhi (astron.), Skt.-Mal., Anon. **Ms.** 13241-G.

Raṇadīpikā (astrol.), by Kumāra Gaṇaka, in 8 chs. **Ms.** C. 531-D.
Qn. in *Praśnamārga* (A.D. 1650). **Edn.** *TSS* 95. **Ref.** Ul. II. 112-13 ; Va. II. 725-29.

Ravi, (*c*. 1425-1530), Teacher of Nīlakaṇṭha Somayāji.
—C *Ācāradīpikā* on *Muhūrtāṣṭaka*
Ref. *Ker. Astron.*, p. 55, § 25 ; Ul. II. 113-14.

Ravisaṅkramādigaṇitam (?) (astron.), Mal., Anon. **Ms.** 6132-B (200 gr.).

Rājarāja Varmā I : Vidvān Karīndran Ceruṇṇi Koyittampurān of Kilimanoor, (1812-46). **Ref.** *Ker. Astron.*, pp. 5-6.

Rājarāja Varmā II : A.R. Rajaraja Varma Koyittampurān, (1853-1918).
—*Karaṇapariṣkaraṇa*
—*Pañcāṅgaśuddhipaddhati*
—C *Jyotiṣaprakāśana*, on the *Golādhyāya* of Bhāskara II.
Ref. *Ker. Astron.*, pp. 80-81, § 81 ; Ul. V. 791-827 ; Ul Sup. II. 436-49 ; Va. VI. 27-65.

Rāma I, Teacher of the anon. au. of *Laghuhorāvivaraṇa* (Mal.).
Ref. *Ker. Astron.*, p. 67, § 47.

Rāma II : Rāman Āśān (18th cent.), astrological authority, father of Kṛṣṇadāsa. **Ref.** *Ker. Astron.*, p. 5 ; p. 74 § 65.

Rāma-Śiṣya (17th cent.)
—C *Laghuorāvivaraṇa* on *Laghuhorā*
—C on *Horā*
Ref. *Ker. Astron.*, p. 67, § 47.

Rāmapraśna (pra.), Skt.-Mal., Anon. **Ms.** 13294-J.

Rāma Varmā Koyittampurān of Grāmam, (1853-1916).
—*Jyotiṣapradīpa*
Ref. *Ker. Astron.*, p. 80, § 80 : Ul. IV. 544-46.

Rāma Vāriyar of Kaikkulangara, (1853-97).

—*Gaulīśāstram* (Mal.)

—*Sāmudrikaśāstra* (Mal.)

—C (Mal.) on *Horā*

—C (Mal.) on *Praśnamārga* (*Pūrvārdha*)

Ref *Ker. Astron*., p. 80, § 81 ; P.V. Krishna Variyar, life sketch, in Mal., in his book *Maṇ maraññа sāhityakāranmār* ; Ul. IV. 267-76 ; Ul. Sup. II. 107-16.: Va. IV. 587-607.

Rāmāyaṇākṣarapraśna (pra.), Anon. Ms. Paliyam List, 826.

Rāśigolasphuṭānīti (astron. rationale), by Acyuta Piṣaraṭi.

Mss. 755 (cat. as *Gaṇitayuktayaḥ*) [G] (ff. 1-13) ; Mad. Mal. D. 339, pp. 90-95. Edn. With Tr. K.V. Sarma, Adyar Lib., Madras, 1955. Ref. Va. IV. 224-25.

Rāśidvayānayanam (?) (arith.), Anon.

Beg. rāśyor yogādighāto vargayogas tadantaram /

Ms. L. 1354-F (inc., 110 gr., with a few instructions in Mal.)

Rāśipramāṇādiphalam (?) (astrol.), Mal., Anon.

Beg. pantraṇṭu rāśi vaccu ayanacalanam kūṭṭi ...

Ms. L. 385-B.

Rāśiphalam (astrol.), Mal. prose, Anon. Ms. 10717-C.

Rāśiphalasāropadeśa : See under *Sāropadeśa*.

Rāśimānādigaṇita (?) (astron.), Mal. verse, by Śaṅkara of Mahiṣamaṅgalam.

Beg. tumpa tiṅkaḷoṭu gaṅga tanneyum etc. (1) ;
candro rudro jayo vidyā nayas tena khanī raveḥ /
triṁśannāḍyābni guḷiko dinapañcamavan niśi //
śrīvallabhaykku meṣādi rāśimānaṅṅaḷ collinen /
rāgaughamunimaunam hariṇakhariṇagānimān //

Ms. C. 2297-C.

Rāśivarṇādivicāra (astrol.), Skt.-Mal., Anon. Ms. 13194-E.

Rāśisaṁjñādividhi (astrol.), Anon. Ms. 13451.

Rudra I : Uzhutra Vāriyar, (*c.* 1325-1400), Teacher of Parameśvara of Vaṭaśreṇi. **Ref.** *Ker. Astron.*, p. 50, § 21.

Rudra II : Uzhutra Vāriyar, (*c.* 1475-1550).

—*Aṣṭamaṅgalapraśna*

—C *Naukā* or *Vivaraṇa* on Horā

Ref. *Ker. Astron.*, p. 62, § 36 ; Ul. II. 114-17 ; Ul. Sup. I. 234-35 ; Va. I. 531-34.

Rekhāpraśna (pra.), Mal.. Anon , 60 gr.

Beg. maṇḍalajñānattiṅkalum anaṣṭye kelpām mārkaṇḍanān paṇḍu pramerkupperapuranākum vasikkumeṭam (?)

Ms. C. 1796-B.

Rekhāpraśna (ārūḍha-pra.), Mal. prose, Anon. Ms. T. 304-C.

Rogapraśna (pra.), Mal. prose, Anon. Ms. 10582-C-1.

Rogalakṣaṇa-dūtalakṣaṇādi (pra.), Mal. prose, Anon.

Beg. praśnam vacca rāśiyuṭe aṣṭamādhipati yātoru rāśiyil ninnu ...

Ms. PM. 4077-F.

Lakṣaṇapraśna I (pra.), Mal. prose, Anon. Ms. T. 1496.

Lakṣaṇapraśna II (pra.), Mal. verse, Anon. Ms. 5109-C.

Lagnaprakaraṇa (astron.), by Mādhava of Saṅgamagrāma, 225 gr.

Ms. 414-B, L. 1360-C ; Mad. Mal. D. 339.

Lagnādiphalam (astrol.), Mal. prose, Anon. Ms. 5109-E.

Lagnādyanayanam (astron.), Mal. prose, Anon. Ms. 5109-K.

Laghukalārpaṇam (astron.), in 8 chs., 500 verses.

Beg. māyām āśritya sṛṣṭvā jagad idam akhilam svapnavat svasvarūpe.

Ms. Mad. R. 5185 (a). **Ref.** Va. 390-91.

Laghujātaka or *Laghuhorā* : See *Laghuhara.*

Laghujātakapaddhati (jā.), Anon.

natvādyam parameśvaram gaṇapatim ... (1)
Kṛṣṇīyād aparāc ca sāram api ... (1) ;
janmāyuktaphalāni janmasamaye ... (2)

Ms. Whish 144 (2).

Laghudarśinī (astrol.), by Nārāyaṇa. Ms. 844-B.

Laghu-Praśnamārga (pra.), Anon. Ms. Payyalikkā Illam, Kottayam, 31-A.

[*Laghubhāskarīya* (astron.), by Bhāskara I]

Do.—C I, *Vivaraṇa* by Śaṅkaranārāyaṇa. Mss. 4258, C, 1681, T. 277. Edn. *TSS* 162. Ref. Raja, 128-29 ; Ul. I. 165-67 ; Va. 221-23.

Do.—C II *Sundarī*, by Udayadivākara (Ker. ?), (A. D. 1073). Mss. C. 1885, P. 942-45 ; P. 977, T. 301.

Do.—C III, by Parameśvara of Vaṭaśreṇi. Mss. 8324-B, C. 1079-A, C. 1348-B ; T. 19 ; Ad. ; Mad. Edn. *Ānandāśrama Skt. Ser.*, 128, Poona, 1946.

Do.—C IV (Mal.), Anon.

Beg. karabadarasadṛśam akhilam bhuvanagatam yatprasādena.

Ms. P. 946 (inc.)

Do —C V (Mal.), Anon.

End : grahagaṇitakarmmaṅṅaḷuṭe nibandham saṅkṣepeṇa Bhāskaranāl collapepeṭṭu kazhiññu.

Ms. 5157 (inc., 700 gr.).

Do.—C VI (Mal.), *Bālaśaṅkaram*, by Śaṅkara of Mahiṣamaṅgalam.

Ms. C. 2146-A (inc , 350 gr.). Ref. Ul. II. 471-72.

Do.—C VII (Mal.), Anon., 1500 gr.

Beg. ellārkkum uḷḷile nilkkum mānatteyum naṭappavan /
katiron ennabhīṣṭaṅṅaḷ ellāyppozhum varuttuka //

Mss. C. 1702, T. 286, T. 862. Ref. Ul. II. 650-51.

[*Laghumānasa* (astron.), by Muñjāla]

Do.—C I, *Vāsanā* or *Mānasagrahajñānavāsanā*, by Sūryadeva Yajvan, Mss. P. 949, T. 38.

Laghumānasa (contd.)

Do.—C II *Parameśvara*, by Parameśvara of Vaṭaśreṇi, 600 gr.

Mss. C. 760-B, T. 28 ; Ad. ; Mysore. **Edn.** *Ānandāśrama Skt. Ser.*, 123, Poona, 1944.

Do.—C III (Mal. prose), *Mānasagaṇitam* (?), *Mānasocitam* (?) or *Mānasam eṇṇum prakāram*, by Putumana Somayāji (?)

Beg. gaṇeśā ninnu vandiccen *Mānasam* kathayākkuvān /
mandacetassukaḷkkellām pāṭham ākkām iteṉṭaham //
... *Mānasam eṇṇum prakāram.* abdam vaccu pattil perukki appaṭi vaccu eṭṭil koṇṭu mel kūṭṭuka.

Mss. 5129-D (inc., 120 gr.), E (inc, 75 gr.). **Authorship.** Suggested on the basis of the tradition that Putumana Somayāji has written a *Mānasagaṇita* and the similarity in the wording of the initial verse above with certain expressions like *alpacetasām* found in the initial verses of the other works of this author.

Laghumānasa : See also *Mānasa*.

[*Laghuhorā* or *Laghujātaka* (astrol.), by Varāhamihira]

Do.—C, *Laghuhorāvivaraṇa*, free rendering in Mal. verse, by a pupil of Rāma, 500 gr., A.D. 1640. **Mss.** 719-A, P. 4320-A.

Lāñchanaśāstra I (pra.), Anon.

Beg. saccidānandarūpāṇām gurūṇām karuṇāvatām /
kaṭākṣapālyaḥ kurvantu satatam mama maṅgalam //
ataḥparam mṛter lakṣma vakṣye tallāñchanais saha /

Ms. T. 7.

Lāñchanaśāstra II (pra.), by Śaṅkara : See *Sāmudrikasāra*.

Lāṭavaidhṛtagaṇitam (?) I (kar.), Mal. verse, Anon.

Beg. veṇṭunnerattinarkkendurāhūṇām sphuṭam ānayet /

Ms. L. 1328-D (inc., 100 gr.).

Lāṭavaidhṛtagaṇitam (?) II (kar.), Mal. prose, Anon.

Beg. lāṭavaidhṛtaṅṅaḷe gaṇikkum prakāratte collunnū—yātoru māsaṅṅaḷile ...

Ms. L. 1221-D (80 gr.).

Lāṭavaidhṛtādigaṇita (?) I (kar.), Mal. prose, Anon.

Beg. lāṭavaidhṛtam eṇṇunna prakāram atha collinen /

Ms. 12687-F (130 gr.).

Lāṭavaidhṛtādigaṇita (?) II (kar.), Mal., Anon.

Mss. 13294-A (180 gr.), C. 563-E (50 gr.), L. 638-B (550 gr.).

[*Līlāvatī* (arith.), by Bhāskara II]

Do.—C I, by Parameśvara of Vaṭaśreṇi. Mss. 5783, 10614-B, C. 295, P. 953 ; Ad. ; Mad. R. 5160.

Do.—C II, *Karmadīpaka*, *Karmapradīpikā* or *Kriyākramakarī*, by Nārāyaṇa : I. Shorter version, 2000 gr. Mss. 6069, 8978, 12806-A, C. 169, C. 306, C. 628-A, TM. 266 ; Ad. ; Mad. D. 13484, Mad. R. 3497. (The reading, "*etan Mādhavākhyena* racitam Karmadīpakam", found in Mad. R. 3497, is an obvious interpolation, violating even the metre, in place of the normal reading "etan *Nārāyaṇākhyena*°.")

Do.—C III, *Karmadīpaka*, *Karmapradīpikā* or *Kriyākramakarī*, by Nārāyaṇa : II. Longer version, 6750 gr. Ms 12814, T. 200, Mad. D. 2754(a) ; Ms. with K.V. Sarma. Ref. Ul. Sup. I. 227-28.

Do.—C IV (Mal.), Anon., 2100 gr.

Beg. yogāśrayam pāpaviyogahetukam
guṇālayam hāram aśeṣaduṣkṛtām /
kṛtiśvaram vedagirām param padam
ghanatviṣam gopakumāram āśraye //
iviṭe dravyattinṟe oro saṁjñakaḷe collunnū.

Mss. 1286-B, 5786, 2813, C. 7-A, C. 2334, L. 878-B, L. 1328, T. 15.

Do.—C V (Mal.), Anon.

Beg. abhipretārthasiddhyartham pūjito yas surair api /
sarvavighnacchide tasmai gaṇādhipataye namaḥ //
aham tam mātaṅgānanam natvā ...

Mss. 3636, L. 839.

Do—C VI (Mal.), Anon.

Beg. ācāryan iṣṭadevataye namaskariccu *Līlāvatiye* camaykkunnuṇṭennu collunnū.

Mss. 14219-C (fr., 50 gr.), C. 1992-A (inc., 2000 gr.), L. 878-B.

Līlāvatī (contd.)

Do.—C VII (Mal.), Anon.

Beg. varāṭakaṅṅal 20 kūṭiyatu oru kākiṇī.

Ms. T 890 (inc., 1500 gr.). **Ref.** Ul. III. 242-43.

Do.—C VIII (Mal.), Anon.

End : avarkku ellāyppozhum sukham sampattu vardhikkunnū, *Līlāvatiyile* aṅkaparimāṇavyavahāram kazhiññu. Līlāvatiyum kazhiññū.

Ms. 10648 (inc., 200 gr.).

Do.—C IX (Mal.), Anon.

Beg. na guṇo na haro na hṛtir na ghanaḥ pṛthulas tathā /

Ms. 12559 (inc., 1200 gr.).

Do.—C X, *Bhāskarīyagaṇitavyākhyā*, by Goda Varmā, Vidvān Iḷaya Tampurān of Koṭuṅṅallūr. **Men.** Ul. IV. 31-32; Va. IV. 318; RNP IV. 400.

Do.—XI, by Dāmodaran Nampūtiri of Maṅgalaśśeri family.
Men. Va. III. 379.

Līlāvatī II (arith.), Mal. verse, Anon.
Mss. 3637-C, 14219-C.

Vakramauḍhyādigaṇitam (kar.), Mal. prose and verse, Anon. Epoch : Kali day 17,01,448 (A D. 1557).

Beg. ahargaṇatte vacciṭṭu 'devavākyajñāsūrya'ne /
kaḷaññā śeṣam saṁskruddhair hariccāl śeṣamuḷḷatil //

Ms. PM. 4368-H (80 gr.).

Vastrādiphalanirṇaya (?) (astrol.), Skt.-Mal., Anon.
Ms. T. 120 (250 gr.).

Vararuci I (4th cent. ?), legendary promulgator of the *Kaṭapayādi* notation.

—*Gīrṇaḥ śreyādi-Candravākyāni.*

Ref. *Ker. Astron.*, p. 43. § 3; Raja, 120-22, Ul. I. 77-81, 195; Va. I. 90-95.

Vararuci II, (Ker. ?), Apocryphal au (?)

—*Keraladvādaśabhāvavākyam*

—*Vararucikerala*, *Jātakarahasya* or *Keralanirṇaya*

—*Vārarucika*

— Certain other doubtful or apocryphal works.

Ref. *Ker. Astron*., p. 43, § 4.

Vararucikerala, *Jatakarahasya* or *Keralanirṇaya* (astrol.), (Ker. ?)

Ref. Ul. I. 164, 165.

Vararucivākyam : See *Gīrnaḥ śreyādi-Candravākyāni*.

Varṣalakṣaṇa (nat. astrol.), Skt.-Mal., Anon. Ms. 6914-A.

Vahni, (19th cent.), Teacher of Puruṣottama, au. of *Praśnāyana*.

[*Vākyakaraṇa* I (kar.), ascribed to Vararuci III]

—C (Mal.), Anon. Ms. L. 893-C.

Vākyakaraṇa II (astron. methodology) by Parameśvara of Vaṭaśreṇi, 75 gr.

Beg. pūjyapādasya Rudrasya śiṣyo 'yam *Parameśvaraḥ* /
karoti *Vākyakaraṇam* vākyāvayavasiddhaye //

Ms. C. 133-A.

Vākyadīpika (astron), by Parameśvara of Vaṭaśreṇi. **Men.** by him at the close of his C on the *Mahābhāskarīya*.

Vākyadhruvasaṁsakārādi (?) (kar.), Anon.

Beg. ānīya tuṅgamadhyendū vākyārambhadinodaye /
deśāntarākhyasaṁskāram api kṛtvā tayor dvayoḥ //

Ms. PM. 4147-E.

Vākyadhruvādigaṇitam (?) (kar.), Anon.

Beg. Candradhīlagnasaṁyuktam kollasaṅkhyāyutam kramāt /

Ms. PM. 4147-C.

Do.—C (Mal.), Anon.

Beg. 'candradhīlagna' ennu vaccu atil kollasaṅkhya kūṭṭi......

Ms. PM. 4147-C.

Vākyaśeṣam (kar.), Mal., mnemonic tables, Anon.

Mss. See *Ker. Mal.*, pp. 130-31.

Vākyālaṅkāra (kar.), Anon., 'by a Brāhman', in 6 chs., 125 gr.

End : *Vākyālaṅkāra*-nāmāyam grantho viracito laghu :
kenacid dvijavaryeṇa samāpto 'bhūd atisphuṭaḥ //

Ms. C. 2179-B.

Vararucika (astrol.), by Vararuci, in 12 chs., 875 gr. Mss. P. 960, P. 961, T. 506.

Vārādiphala (astrol.), Skt.-Mal., Anon. Mss. 13194-A, L. 385-C.

Vārādiphalanirṇaya (astrol.), Anon.

Beg. ātmajñāni sadāśūraḥ paittikaḥ priyavallabhaḥ /
caturaśratanuḥ śrīmān ravivāre prasūyate //

Mss. CM. 2197-B (cata. as *Vāraphalam* or *Pañcāṅgaphalam*), T. 245.

Do.—C (Mal.), Anon.

Beg. Vārādiphalanirṇayaḥ. ñāyarāzhcaphalam āvatu—ātmajñāni...

Ms. T. 245.

Vārādyadhipatinirṇaya (astrol.), Mal. prose, Anon. Ms. 6007-I.

Vālmīkipraśna (pra.), Mal. prose, Anon. Mss. C. 2289, T. 1000.

Vālmīkiśāstra (pra.), Mal., Anon.

Beg. ini nirūpicca kāryam śubhamo aśubhamo ennu colluka.

Ms. CM. 2293. Rem. For similar works see *Dṛṣṭāntamālā* I, II.

Vasiṣṭhapraśna (pra.), Mal., prose, Anon. Ms. 5974.

Vāsuṇṇi Mūssatu of Veḷḷānaśśeri, (1885-1914)

—C on *Pañcabodha.*

Ref. *Ker.Astron.*, p. 81, § 81; Ul. IV. 698-703; Ul. Sup. II. 373-76.

Vāsudeva I : Vāsudevasvāmī.

—*Kāladīpa.*

Ref. *Ker. Astron.*, p. 69, § 50; Va. III. 392-94.

Vāsudeva II, of Vaḷḷimana in Kaṇṇaṅgalam.

—C (Mal.), on *Muhūrtapadavī* V, in two versions.

Ref. *Ker. Astron.*, p. 72, § 58.

Vāsudeva III, teacher of the anon. au. of *Santānadīpikā*.

Vidyāmādhava, son of Nārāyaṇa, of Nīlamana, near Gokarṇa.

—*Muhūrtadarśana* or *Vidyāmādhavīya*

Ref. *Ker. Astron.*, pp. 48, § 15 ; Ul. II. 95 ; Va. I. 441-44.

Vidyāmādhavīya : See *Muhūrtadarśana*.

Vidvān Iḷaya Tampurān of Koṭuṅṅallūr, (1800-51)

—C *Bhāskarīya-gaṇita-vyākhyā* on *Līlāvatī* of Bhāskara II

—C on *Golādhyāya* of Bhāskara II

Ref. *Ker. Astron.* p. 78, § 75 ; Ul.IV. 31 ff.; Va. IV. 318 ; RNP IV. 400.

Viliptādivākyāni : see *Śīlam rāññaḥ śrīyetyādi*°-

Vivāhapporuttam (astrol.), Mal prose, Anon. Ms. 1416-C.

Do.—See also *Daśapporuttam*, *Poruttam*, *Vivāhānukūlyam*, *Veḷipraśna*.

Vivāhānukūlyam (astrol.), by Parameśvara of Vaṭaśreṇi. Mss. C. 584-A, T. 268-B.

Do.—C I, (Mal.), Anon.

Beg. rāśi-rāśīpavaśyau ... (text.). rāśivaśyavum rāśyadhipavaśyavum bandhuśatrutvavum ...

Ms. C. 584-A.

Do.—C II (Mal.), Anon.

Beg. anantaram vivāhattinu poruttatte paṟayunnu—rāśi-rāśīpavaśyau ... (text). rāśipporuttavum rāśyadhipapporuttavum ennu tuṭaṅṅi eṭṭu poruttaṅṅal pradhānamāyiṭṭu collappeṭunnu.

Ms. T. 268-B.

Viśvārthadīpinī : Name of C (IX) by Parameśvara on *Horā*.

Viṣamākṣaravivṛti : Name of C (IV) by Nityaprakāśa Yati on *Horā*.

Viṣunirṇayādiphala (astrol.), Skt.-Mal., Anon., 300 gr. Ms. L. 1229-E.

Viṣuphalādivicāra (astrol.), Mal. Anon., Ms. 13494-P.

Viṣusaṅkramaphala (astrol.), Mal. verse, Anon., 150 gr. Ms. 6478-C.

Viṣṇu I

—C, *Caturasundarī*, on *Cintājñāna* of *Kṛṣṇīya* or Kṛṣṇa.

Viṣṇu II. son of Vidyāmādhava, of Nīlamana, near Gokarṇa.

—C, *Dīpikā*, on the *Muhūrtadarśana* of Vidyāmādhava.

Ref. *Ker. Astron.*, pp. 49-50, § 16.

Veṇāḍ-dvija, personal name not known; a native of Veṇāḍ (S. Travancore).

—*Jātakodaya* or *Uḍu-jātakodaya*

Veṇvāroha : See also *Candrasphuṭāpti*, *Dṛg-veṇvārohakriyā*.

Veṇvāroha (kar.), by Mādhava of Saṅgamagrāma, for the accurate computation of the moon, in 74 verses. *c.* 1400.

Mss. 10929-C ; Skt. Col., Trippunithura ; Eḷamprakkoṭṭu Mana, Eravoor (Cochin), all with C of Acyuta.

Edn. K.V. Sarma, with elaborate Intro., Skt. College, Trippunithura, 1956. Ref. Ul. II. 99-100 (where the work is wrongly described to contain only 59 verses); Va. III. 388-90.

Do.—C (Mal.), by Acyuta Piṣaraṭi. Mss. With the text mss. above.

Edn. K. V. Sarma, with text above. Ref. Ul. II. 99-100, 651-52.

Veṇvārohakriya (kar.), Anon. Mss. 5867, (ff. 163-65). Edn. K.V. Sarma, as App. II to his edn. of *Veṇvāroha*, above.

Veṇvārohāṣṭaka (kar.), by Putumana Somayāji. Ms. 404 (last folios).

Veḷipraśna (pra.), Mal. prose, Anon. Ms. C. 565-G.

Vaidyanātha-Śiṣya a native of Bhūtanāthapura.

—*Praśnasāra* III.

Vaidhṛta : See also *Laṭavaidhṛta*, *Vyatipātavidhṛta*.

Vaidhṛta (?) (kar.), Mal., Anon., 80 gr. Epoch : Kali day 17,85,699 (AD. 1788).

Beg. vaidhṛtakali 'dhūḷikṣamī hi sevyaḥ'.

Ms. 14219-B.

Vaidhṛtagaṇita (kar.), Mal., Anon.

Beg. vaidhṛtam aṟiyum prakāram—oru graham meṣādiyāyi ...

Ms. 51C9-A (inc., 85 gr.).

Vaidhṛtādyanayanam (?) (kar.), Mal., Anon.

Beg. aṭātu māsam patinañcām tīyati udayattinṟe ādityasphuṭam vaccu raṇṭu tavaṇa ayanam kūṭṭi ...

Ms. 13494-I (180 gr.)

Vyatīpātagaṇitam (kar.), Anon.

Beg. vyatīpātarkṣam abhūhya sāyanāhi-ravī nayet /
rāhos tu kṣepacalanam parakrāntim vidhor api //

Ms. CM. 595-F.

Vyatīpātavaidhṛta (kar.), Anon.

Beg. vyatīpātendusiddhyartham upāyo 'tha pradarśyate /

Mss. C. 595-E, C. 2085-E, L. 1167-A.

Do.—C (Mal.), *Pāṭugaṇippān-Bhāṣā*.

Beg. pātum piṟappum eṇṇeṇtil collunnuṇṭu curukki ñān /
iṣṭagrahayor arkan eṟunnāḷ udayattinu //
arkanil graham eṟunnāḷ eṇṇukastamayattinu /
mīnattil oruvan nilppu maṟṟevan meṣarāśiyil //

Mss. C. 595-F, C. 2085-E, L. 1167-A, PM. 4078-D, PM. 4158-D.

Vyatīpātādigaṇita I (kar.), Anon. **Ms.** 1015-A (200 gr.)

Vyatīpātādigaṇita II (kar.), Mal., Anon. **Ms.** 13057-A (inc., 84 gr.)

Vyatīpātādigaṇita III (kar.), Mal., Anon. **Ms.** 13389-A (inc., 115 gr.)

Vyatīpātāṣṭaka I (kar.), Anon. **Beg.** candra ... **Mss.** of the work are not known but that of its C is known.

Do.—*Vṛtti*, in verse, by Parameśvara of Vaṭaśreṇi. **Ms.** 788-D.

Vyatīpātāṣṭaka II (kar.), Anon.

Ref. Two verses beg. with *saṁskṛtyāyanayor bāhvoḥ* and *visarpaś śaśibāhor yat*, quoted by Nārāyaṇa in his C (I) on *Pañcabodha* IV, verse I. 2. It is not known whether *Vyatīpātāṣṭakas* I and II are the same.

Vyāghrapāda, apocryphal author.

—*Aṅkaṇaśāstra*, *Grahasamaya* or *Navagrahasamaya*

Ref. *Ker. Astron.*, p. 47, § 11.

Śakābdasaṁskārakriyā (astron.), Mal, an exposition of *Karaṇapaddhati*, I. 12, 13 depicting the *Śakābdasaṁskāra* of *Grahacāranibandhana*. Anon., 100 gr. **Ms.** 5820-C. **Edn**. App., (pp. 307-11), to the edn. of *Karaṇapaddhati*, Madras, 1956.

Śakunamuṣṭi : See *Dṛṣṭāntamālā*.

Śaṅkara I (*c.* 1475-1575), younger brother of Nilakaṇṭha Somayāji of the Garga gotra, hailing from the Keḷallūr family. **Ref.** *Ker. Astron.*, p. 57, § 27.

Śaṅkara II : Śaṅkara Vāriyar (*c.* 1500-60) of Tṛkkuṭaveli family, follower of Nīlakaṇṭha Somayāji.

—*Karaṇasāra*

· C on Do.

—C *Kriyākalāpa* on the *Tantrasaṅgraha* of Nīlakaṇṭha Somayāji

—C *Laghuvivṛti* on the *Tantrasaṅgraha*

—Anon. work on astron., quoted by himself in his *Laghuvivṛti*, on *Tantrasaṅgraha*, II. 15, 16.

Ref. *Ker. Astron*, pp. 58-59, § 31 ; Raja, 155 ; Ul. II. 120-21.

Saṅkara III : Śaṅkaran Nampūtiri, (1494-1570), of the Mahiṣamaṅgalam (Mal. Mazhamaṅgalam) family, near Trichur, pupil of Parameśvara of Vāzhamāveli.

—*Ayanacalanādigaṇitam* (Mal.)

—*Kāladīpaka* I (shorter version) (Mal.)

—*Kāladīpaka* II (longer version) (Mal).

—*Gaṇitasāra* (II) (Mal.)

Śaṅkara III (contd.)

—*Candragaṇitakrama* (Mal.)

—*Jātakakrama* (Mal.)

—*Jātakasāra* I (Skt.)

—*Jātakasāra* II (Mal.)

—*Pañcāṅga* (muhūrta) for 1000 years.

—*Praśnamālā* (Skt.)

—*Rāśimānādigaṇita* (Mal.)

—C (Mal.) *Bālaśaṅkaram* on *Kāladīpaka* II

—C (III) (Mal.) Do. on *Pañcabodha* IV

—C (IV) (Mal.) Do. on *Muhūrtapadavī* II

—C (VI) (Mal.) Do. on *Laghubhāskarīya*

—C (Mal.) *Pañcabodhakriyākrama* on *Pañcabodha* II

—C (II) (Mal.) *Pañcabodhārthadarpaṇa* on *Pañcabodha* IV

—C (Mal.) on his own *Praśnamālā* (?)

Ref. *Ker. Astron.*, pp. 62-64, § 37 ; Raja, 155-56 ; Ul. II.269-72 ; 469-75 ; Va. II. 613-22.

Śaṅkara IV of Muktisthala (Mal. Mūkkōla), pupil of Nārāyaṇa and Dāmodara, and protégé of the Zamorin of Kozhikode.

—*Āyuḥpraśna*

—*Sāmudrikasāra*, *Ārūḍhapraśna* or *Lāñchanaśastra*

Ref. *Ker. Astron.*, p. 75, § 66 ; Ul. III. 86-87 ; Va. II 718-23.

Śaṅkara V

—*Jātakasāra* III (Mal.)

—*Praśnasāra* I (Mal.)

—*Praśnānuṣṭhānapaddhati* I (?)

—*Praśnānuṣṭhānapaddhati* II

Ref. *Ker. Astron.*, p. 75, § 67.

Śaṅkara VI, Teacher of the anon. au. of *Ācāradarśana*.

Śaṅkara VII, (19th cent.), Teacher of Puruṣottama (au. of *Praśnāyana*).

Śaṅkara VIII, Teacher of Parameśvara, (au. of C IX, *Viśvārthadīpinī* or *Jātakacandrikā*, on *Horā*).

Śaṅkara IX : Śaṅkarakavi.

—C on *Muhūrtapadavī* III

Śaṅkaranārāyaṇa, (*c*. 825-900), court astronomer of King Ravi Varmā of Mahodayapuram.

—C *Vivaraṇa* on the *Laghubhāskarīya* of Bhāskara I

Ref. *Ker. Astron.*, p. 45, § 7 ; Raja, 128-29 ; Ul. I. 165-67 ; Va. IV 221-23.

Śaṅkara Varmā or Appu Tampurān, (1800-38), a prince of the royal house of Kaṭattanāḍ in N. Malabar.

– *Sadratnamāla*

—C (Mal.) on Do.

Ref. *Ker. Astron.*, p. 78, § 76 ; Raja, 165-66 ; Sen, p. 191 ; Ul. III[1] 499-501 ; Ul. Sup. I. 635-37 ; Va. IV. 384-93.

Śīlam rājñaḥ śriye'tyādi viliptādi-Candravākyāni (kar.) by Mādhava of Saṅgamagrāma. Mss. C. 2297-C, MC. 595-A; P. 4116 B ; Eḷamprakkoṭṭu Mana, Eravoor (Cochin). Edn. K. V. Sarma, with Notes, as App. I to his edn. of *Veṇvāroha*, Skt. College, Trippunithura, 1956.

Śukrakerala, *Bhṛgukerala* or *Keralarahasya* (Ker. ?). Ref. Ul. I. 164, 165.

Śuddhacandrādigaṇita (?) (kar.), Mal., Anon.

Beg. candrane sūkṣmamāyiṭṭu gaṇippān kriya collinen /

Mss. 5812-B, 12686-C.

Śuddhacandrārkagaṇita or *Sūkṣmacandrārkagaṇita* (?) (kar.), Mal., Anon.

Beg. śuddhamāyi gaṇikkeṇṭū candrārkanmāreyeṅkilu /

Mss. 10856-E, 13225, 13294-L, 13298, L. 336-G, L. 1167.

Śubhāśubhanimittāni (nat. astrol.), Skt.-Mal., Anon.

Beg. guḷiko viṣṭi gaṇḍāntam viṣoṣṇaikārgaḷā amī /
varjyāḥ sarpaśiro lāṭo vaidhṛtaś ca sukarmasu //

Ms. C. 49-C (200 gr.)

Śyāmalavāraṇarāja, a prince.

—C on the *Kālādīpa* of Vāsudevasvāmi

Ref. See above, pp. 69-70, § 51 ; Va. III. 392-93.

Śrāddhacandrādigaṇana-kriyāsaṅgraha : See *Kriyāsaṅgraha*.

Śrāddhacandrādigaṇita I (kar.), Anon., misc. calculations, 1400 gr. Ms. 5812.

Śrāddhacandrādigaṇita II (kar.), Mal. prose, Anon. Mss. See *Ker. Mal.*, p. 148.

Śrīkaṇṭha of Veḷḷārakkaḍ in Cochin.

—C (Mal.), on the *Jātakapaddhati* of Parameśvara (?)

Śrīkumāra, son of Nīlakaṇṭha and pupil of Nārāyaṇa, of the village of Dvipakānana (? Mal. Ānakkāḍ).

—*Praśnāmṛta*

Ref. *Ker. Astron.*, p. 76, § 70.

Śrīpatipaddhati : See *Jātakakarmapaddhati*.

Śrīvallabha, Teacher of the anon. au. of *Ācāradarśana*.

Ślokapañcāśikā (muh.), Anon. (Ker.?)

Beg. gurum bhaktyā namaskṛtya tatprasadād yatāmahe /
vivāhādipratiṣṭhāntakarmaṇām kālavittaye //

Ms. P. 965.

Ṣaḍvargaphalam (astrol.), by Parameśvara of Vaṭaśreṇi. Mss. C. 133-B, T. 116-B.

Saṅkramadhruvānayana (kar.), Mal. prose, Anon., 40 gr. Ms. 13225-C.

Saṅkramadhruvānayanādi (?) (kar.), Anon. Epoch, Kali year 4597 (A.D. 1495).

Beg. 'sindhuśobho'nitābdaghne śāstrārthe jayanāḍikāḥ /

Ms. L. 1328-E.

Saṅkrāntidhruvānayana (kar.), Mal. prose, Anon., 15 gr. Ms. 13294-F.

Saṅkrāntivākya I (kar.), Anon., 10 gr.

Beg. āgāmi mitram vibudhākṛtīnām /
nanarta śaurir vanabhūratajñaḥ //

Ms. CM. 595-G.

Saṅkrāntivākya II (kar.), Mal. prose, Anon. Ms. 12686-B.

Saṅkrantisphuṭādigaṇita (?) (kar.), Mal. prose-verse, Anon. Epoch, Kali day 17,21,462 (A.D. 1613).

Beg. 'prītāsvādyarasāyano'nadivasān modāḍhyaputram tyajet.

Mss. 1005-C (inc., 130 gr.), L. 1175-C.

Saṅkrantyādigaṇita (?) (kar.), Mal., Anon.

Beg. śṛṅgāṇi meror divi dhūpitāni
cakre ca śakro nava viśrutāni /
praṇauti rudram bhayavaṁśabhinnam
varam hi bhakto havi divyayānaṇ //

Ms. L. 1173 (160 gr.).

Saṅgrahasādhanakriyā (kar.), by Āzhvāñceri Tamprākkaḷ, 150 gr., on computation-procedures implied in his *Jyotiśśāstrasaṅgraha*.

Beg. *Saṅgrahe* paṭhyamānānām sādhanānam kriyocyate /

Mss. C. 2431-C, L. 1355-A, TM. 233-D.

Do.—C (Mal.), by the author himself. **Mss.** L. 1177, L. 1218, T. 233-C.

Saṅgrāmavijayodaya (nat. astrol.), Anon., (Ker. ?). Q by Rudra II (16th cent.) in his C on the *Horā*. **Mss.** Ker., Mad. **Edn.** *TSS* 123. **Ref.** Ul. II. 111-12; Ul. Sup. I. 215.

Sadratnamālā (kar.), by Śaṅkara Varmā, A.D. 1823, 6 chs., 300 gr.

Mss. 8322-B, C. 2136; Ad.; Mad. **Edn.** Serially in *Kavanodayam*, (Mal. Jl., Kozhikode), vol. 16 (1898). **Ref.** Raja, 165-66; Sen, p. 191; Ul. III, 499-501; Va. IV. 384-93.

Do.—C (Mal.), by the author himself. **Mss.** 8322-B, T. 1175. **Edn.** up to VI. 32, with the text above. **Ref.** Ul. III. 501; Ul. Sup. I. 636-37; Va. IV. 389-93.

Santānadīpikā (astrol.), Anon., by a pupil of Vāsudeva, 100 gr.

Beg. gurunātham namaskṛtya gaṇanātham praṇamya ca /
Vāsudevam gurum dhyātvā vakṣye *Santānadīpikām* //

Mss 610-A, 1416, 12810-B, C. 134-C, P. 968, PM. 4077-D, T. 286-A; Ad.; Mad. **Edn.** G. Kocchusankaran Vaidyan, S. T. Reddiar and Sons, Quilon, 2nd edn., M.E. 1105. **Ref.** Ul. III. 90; Ul. Sup. I. 464-65; Va. II. 501.

Santānādipraśnavicāra (pra.), Skt.-Mal., Anon. Ms. 13494-B.

Samudravākya : See *Kuiādīpañcagraha-mahāvākya.*

Sampradāyapradīpikā : Name of C by Govindasvāmin on *Parāśarahorā.*

[*Sāmudrikalakṣaṇa* I (physiognomy), Anon.]

Do.—C I (Mal.), Anon.

Beg. munpil āyussulakṣaṇam arika. āyussilleṅkil maṭṭuḷḷa lakṣaṇam nokkeṇṭa.

Ms. P. 970-A.

Do.—C II (Mal.), Anon.

Beg. munpil āyussine parīkṣikkaṇam. pinne lakṣaṇatte collaṇam.

Ms. P. 971-B.

Do.—C III (Mal.), Anon. Mss. 13204-A, C. 2079-B, L. 101 B, L. 216-B.

Do.—C IV (Mal.), unidentified ; possibly, one of the above.

Ref. Va. III. 642-45.

Sāmudrikalakṣaṇa II (physiognomy), Skt.-Mal., Anon. Mss. 12721-C, 13389-B, 14311-B.

Sāmudrikalakṣaṇa III (physiognomy), Mal. prose, Anon Mss. L. 206-B, T. 126-A-2.

Sāmudrikaśāstra (physiognomy), (Mal.), by Rāma Vāriyar of Kaikkulangara. Ref. *Ker. Astron.*, p. 80, § 81.

Sāmudrikasāra, *Ārūḍhapraśna* or *Lāñchanaśāstra*, (omenology-pra.), by Śaṅkara of Muktisthala. Mss. L. 101-A, C. 137-B (cata. *Ārūḍhapraśna*) ; Ad. Ref. Ul. III. 86-87 ; Va. II. 723 (*Ārūḍhapraśna*).

Do.—C I (Mal.), Anon., 150 gr.

Beg. gaṇeśam ṣaṇmukham rudram umādevīm sarasvatīm /
samvandya bhāṣayā vacmi *Lāñchanam* tu yathāśrutam /
āyupraśne jīvatām iti. tatrātha jīvata iti. vṛddha-darśanattinnu paññikkūṭṭam

Ms. C. 137-C.

Samudrikasara (contd.)

Do.—C II (Mal.), Anon.

Beg. aviṭe naṭe kaittalattiluḷḷa sthānaṅṅaḷeyum aviṭeyuḷḷa rohiṇī tuṭaṅṅiyuḷḷa rekhakaḷeyum ...

Ms. L. 101-A

Sārasaṅgraha : See also *Praśnasārasaṅgraha.*

Sārasaṅgraha (astrol.), Anon., in 9 chs.

Beg chāyā-jalayantrādyair avagamya dyugolanāḍikāḥ praśne /
sāvayavās tābhir ayam prāglagnavidhir nigadyate spaṣṭam //

Ms. C. 134-B.

[*Sāropadeśa* (astrol.), Anon.]

Do.—C (Mal.)

Beg. (of text) : Meṣādirāśiphalam—
piṅgākṣaḥ paittikaḥ krodhī sabhāmānyaḥ suvikramaḥ /
lubdhaḥ kṛtī ca capalo meṣarāśyām tu jāyate //

Ms Mad D. 13914.

Siddhāntadarpaṇa (siddhānta), by Nīlakaṇṭha Somayāji, in 32 verses.

Mss. See Intro. to edn. **Ed.** and **Tr.** by **K. V. Sarma,** Adyar Library, Madras, 1955. **Ref.** Va. IV. 225.

Do.—C by the author himself. **Ms.** P. 975.

Siddhāntadarpaṇa-siddha-paryayādayaḥ (astron.), Anon., 17 verses.

Ms. 5867 (ff. 169-72). **Ed.** and **Tr.** by K. V. Sarma, with the edn. of *Siddhāntarpaṇa* above.

Siddhāntadarpaṇastha-paryaya-bhūdināni (astron.), Anon., 3 verses.

Mss. C. 2740 (fol. 98 b), C. 2314 (fol. 74). **Ed.** and **Tr.** by K V. Sarma, in the edn. of *Siddhāntadarpaṇa,* above.

Sundararajapraśnottara (astron.), by Nīlakaṇṭha Somayāji.

Mss. Yet to be identified, but the work is mentioned by both Nīlakaṇṭha in his *Āryabhaṭīya-bhāṣya* (*TSS* 185, p. 149)

Sundararājapraśnottara (contd)

and Sundararāja in his C on the *Vākyakaraṇa* (Edn. T.S.K. Sastri and K.V. Sarma, K.S.R. Inst. Madras-4, 1962, p. 119).

Sundarī : Name of C by Udayadivākara on the *Laghubhāskarīya* of Bhāskara I.

Subodhārthinī : Name of anon. C on *Horā*.

Subrahmaṇya I, a Nampūtiri of the Māttūr family, *c*. 1475-1535.

—*Muhūrtapadavī* III (A.D. 1531).

Subrahmaṇya II, (1835-1903), a Tirumunpu of the Kunnattu family in Payyannoor, in N. Malabar.

—C *Bhāvaprakāśa* on the *Muhūrtadarśana* of Vidyāmādhava.

Ref. *Ker. Astron.*, p. 79, § 78 ; Ul. Sup. I. 540 ; V. I. 444.

Subrahmaṇya III (? alias Parameśvara, pupil of Śaṅkara)

—C (IX), *Jātakacandrikā* or *Viśvārthadīpinī* on *Horā* (acc. to Ms. 5581).

Subrahmaṇya Śāstri, (1828-88), of the Nalleppaḷḷi village in Cochin.

—*Agaṇitam* (kar.)

Ref. *Ker. Astron.*, pp. 78-79, § 77 ; Ul. IV. 292 : Ul. Sup. II. 122-23 ; Va IV. 607 ; RNP IV. 481-82.

Sūkṣmacandrārkagaṇita : See *Śuddhacandrārkagaṇita*

Sūkṣmacandrasphuṭādigaṇita (kar.), Mal. prose, Anon.

Ms. 12686-C.

Sūryagrahaṇagaṇitam (ecl.), Mal. verse, Anon. 50 gr.

Ms. L. 765-D.

Sūyacandracchāyāgaṇitam Bhāṣā (?), (kar.), Anon., Mal. verse.

Beg. pāṭum pirappum eṇṇeṇṭum prakāram iha collinen /
iṣṭagrahayor arkan erunnāḷ udayattinu //
ādityād graham erum nāḷ eṇṇukās'amanattinu /
ādityane sphuṭikkeṇam appoḷ veṇṭum grahattinu //

Mss. PM. 4027, 4158-E.

Sūryacchāyādigaṇita I (?) (kar.), Mal., Anon.

Beg. sūryacchāya gaṇikkunna prakāram atha collinen /
talkālasāyanārkkannu caram meṣādi uttaram //

Mss. 5109-D (cata. *Sūryacchāyāgaṇita*, 70 gr.), L. 251-C (cata. *Candracchāyāgaṇita*, 320 gr.), 5042-D, 10647-E, 13493-E, all differing slightly from one another.

Sūryacchāyādigaṇita II (kar.), Mal. verse, Anon. **Mss.** 5042-D, 5109-D, 13493-E.

Sūryadeva Yajvan, (1191-*c.* 1250), of Nidhruvagotra
—C *Prakāśa* or *Prakāśikā* on *Āryabhaṭīya*
—C *Jātakālaṅkāra* on the *Jātakakarmapaddhati* of Śrīpati
—C on the *Mahābhāskarīya-bhāṣya* of Govindasvāmin
—C on the *Mahāyātrā* of Varāhamihira

Ref. *Ker. Astron.*, p. 48, § 14 ; Raja, 131-32 ; Sen, p. 214 ; Ul. II. 97-98 ; Ul. Sup. I. 219 ; Va. I. 390-92.

Sūryamadhyamādigaṇita (?) (kar.), Mal., Anon. **Ms.** 13394-I.

[*Sūryasiddhānta* (siddhānta)]

Do.—C I, *Vivaraṇa* by Parameśvara of Vaṭaśreṇi. **Ms.** 8358-J.

Do.—C II (Mal.), by Acyuta Piṣāraṭi (?)

Beg. **gurūṇām caraṇāmbhojaparāgaparamāṇavaḥ /
manomukuram asmākam punīyur anuvāsaram //**

aviṭe *Sūryasiddhāntam*ākunna ... gaṇitatte camappān tuṭaṅṅunna ācāryan ...

Mss. 3636-C, 8358-A, T. 251. **Authorship.** **Suggested on** the basis of the characteristic *maṅgala-śloka* of Acyuta Piṣāraṭi, which occurs in his *Uparāgakriyākrama-vyākhyā*, *Karaṇottama*, *Jātakābharaṇa* and *Veṇvāroha-vyākhyā*, and also on the similarity of the beg. of the present C with the beg. of Acyuta's *Veṇvāroha-vyākhyā*.

Sūryasiddhānta-saṅgraha (siddhānta), (Ker. ?). **Ms.** Cranganore Palace List, 4.

Sūryoparāgakriya (ecl.), Mal., Anon.

Beg. nayī jīvas surāgīṇo narastuṅga-śarāsanaḥ /

Ms. 931-C (inc., 100 gr.)

[*Skandaśarīraka* (nat. astrol.)]

Do.—C (Mal.), Anon. **Ms.** P. 979 (interspersed with Skt.).

Sthānaphalādi (astrol.), Mal., Anon. **Ms.** 8269-B.

Sphuṭanirṇaya (astron.), by Acyuta Piṣāraṭi, in 6 chs., devoted respectively, to *Saṅkhyākathana*, *Madhyamānayana*, *Mandasphuṭānayana*, *Bhagolasphuṭānayana*, *Bhūgolasphuṭānayana* and *Bhūpṛṣṭhasphuṭānayana*.

Mss. C. 809-C, C. 964-B, C. 1945-B; Mad. R. 3799 (b); Kanippayyoor Mana, Kunnamkulam; Eḷamprakkoṭṭu Mana, Eravoor; M.S. Srinivasa Sastri, Palghat.

Ref. Sen, p. 202 (where it is noticed as anon. and the subjects of its Chs. IV, V and VI given, wrongly, under the common heading *Bhūgo[la]sphuṭānayana*); Va. IV.225. **Cr. Edn.** by K.V. Sarma.

Do.—C, *Vivṛti*, by the author himself. **Mss.** C. 697-C, C. 809-C, C. 964-B, C. 1945-B; Mad. R. 3792 (b); M.S. Srinivasa Sastri.
Ref. Sen, p. 202. **Cr. Edn.** by K.V. Sarma.

Sphuṭanirṇaya-nirṇīta-paryayādayaḥ (astron.), Anon., 14 verses.

Beg. abhivandya gurum bhaktyā kalpakālaprakīrtitāḥ /
Sphuṭanirṇaya-nirṇīta varṇyante *paryayādayaḥ* //

Ms. With K.V. Sarma. **Cr. Edn.** K.V. Sarma.

Sphuṭanirṇaya-bhagaṇāḥ : See *Tantrasaṅgrahāt Sphuṭanirṇaya-bhagaṇāḥ*. **Cr. Edn.** by K.V. Sarma.

Haridatta, (*c.* 650-700), promulgator, in A. D. 683, of the Parahita system of astronomy in Kerala.

—*Grahacāranibandhana*
—*Mahāmārganibandhana*

Ref. *Ker. Astron.*, pp. 7-9; 43-44, § 5; K.V. Sarma, Intro. to the edn. of *Grahacāranibandhana*, Madras, 1954; Raja, 123-26.

[*Horā* (jā), by Varāhamihira]

Do.—C I, by Kṛṣṇa. Ms. Public Library, Trivandrum, 35.

Hora (contd.)

Do.—C II, in verse, by a disciple of Kṛṣṇa.

Beg. prāyeṇa mandabuddhīnām manuṣyāṇām kalau yuge /
laghunaiva prakāreṇa *Hore*yam upadiśyate //
āyur hi trividham loke pūrṇa-madhyalpanāmabhiḥ /

End. *Kṛṣṇācāryasya Śiṣyeṇa Horeyam* upapāditā /
Kṛṣṇācāryaprasādena prasādāc ca vivasvataḥ //

Ms. IO 6381-D.

Do.—C III, *Daśādhyāyī*, by Govinda Bhaṭṭatiri of Talakkuḷam, 3800 gr. Mss. 957, C. 2141-A ; Mad. D. 14064. Ed. Bombay, Saṁ. 1969 (A.D. 1912) ; Palghat, (1905). Ref. Raja, 132-33 ; Ul. I. 167-79, II. 110 ; Va. I. 353-59.

Do.-C IV, *Prakāśikā* or *Viṣamākṣaravivṛti* by Nityaprakāśa Yati.

Mss. C. 136, C. 227, P. 997, T. 90 ; Ad.

Do.—C V, *Subodhārthinī*, Anon., (Ker. ?)

Beg. ātmāyate vāsarapo 'khilānām
aṅgāyate janmavivarjitānām /
dīpāyate yo jagatām abhīṣṭam
dadhātu naḥ so 'nyatarānapekṣaḥ (1) ; ...
yā *Horā* racitā ... (2) ; athācāryeṇāsya śāstrasyāvighnaparisamāptyartham ...

Mss. C. 1244 ; Ad. ; Mad.

Do.—C VI, *Vivaraṇa* or *Naukā* by Rudra, A.D. 1527, 6000 gr.

Mss. 14267-B, C. 2237 ; Ad. ; Mad. ; Tir. Edn. *TSS* 91, (Trivandrum, 1926 ; 2nd edn., 1958). Ref. Ul. II. 114-17 ; Va. I. 531-34.

Do.—C VII, *Pāṭhyam*, Anon. Ms. P. 892 (inc., 3000 gr.)

Do.—C VIII, *Pārameśvarī* or *Horābhiprāyanirṇaya*, by Parameśvara.

Beg. arkendvārajñavāgīśaśukramandatamodvijāḥ /
praṇamya kriyate spaṣṭo *Horābhiprāyanirṇayaḥ* //
mūrtitve iti. ravir no vācam dadātu ityarthaḥ.

Mss. C. 135-A, C. 2110, T. 79 ; Ad. Edn. *TSS*, Trivandrum, 1963.

Do.—C IX, *Jātakacandrikā* or *Viśvārthadīpinī*, by Parameśvara, pupil of Śaṅkara.

Horā, C IX (contd.)

Beg. yasyaikadeśam āśritya modate nikhilam jagat /
tasmai namo 'stu bhagavate parāya paramātmane //
namāmi śirasā devam *Śaṅkaram gurum* ātmanaḥ /
yasya prasādenājñānam akhilam me nirākṛtam //
*Horātantrā*bdhitārāya śāstrapoto nirūpitaḥ /
*Varāhmihireṇā*sya vyākhyānam kriyate mayā //
mūrtitve (text) ...

Mss. 3634, 5851, 10535, C. 1366-B, L. 552-B, T. 732. **Note.** Ms. 5851 names the au. also as 'Subrahmaṇya.' **Ref.** Va. III. 394.

Do.—C X, Anon., by a pupil of Pūrṇaprajña or Pūrṇaprabodha.

Beg. aviratam atitiṣṭhan maṇḍalācaṇḍabhānor-
niravadhinijatejassyandasandīpitāśaḥ / ... (1)
nikhilajagadupāsyo nityaśo yas trisandhyam
diśatu mama rameśo jyotiṣām eṣa bodham //
*Pūrṇaprajñā*dikāneka-sadguṇā madgurūttamāḥ /
sādhayeyur iman santo māmakīnamanoratham //
... asmin *Horāśāstre* mūrtitva ityādinā prārambha-samuciteṣṭadevatānamaskāraślokena ...

Ms. CM. 6-C (cata. *Ārūḍharāśikathanam*).

Do.—C XI, *Bṛhajjātaka-prathamaślokavyākhyā*, Anon.

Ms. TM. 144-C-1 (45 gr.).

Do.—C XII (Old Mal.), *Prakāśikā* by Nityaprakāśa Yati.

Beg. mūrtitve ... enpatu śaśabhṛttinuṭe mūrttitvam ākkapeṭṭu, apunarjanmākkaḷukku vartmāvāyi, yajvākkaḷukku kratuvumāyi, jyotiṣaṁkaḷukkellām svāmiyumāv, ...

Ms. P. 995. **Note.** This C is diff. from this au.'s Skt. C *Prakāśikā* on *Horā*.

Do.—C XIII (Mal.), *Horāvyākhyānam Tamizhkkuttu*, Anon.

Beg. Horāśāstratte camappān tuṭaṅṅunna ācāryan iṣṭadevatāvandanam ceyyunnu 1 ślokam koṇṭu.

Mss. C. 590, C. 2524, T, 133-B, F.

Horā (contd.)

Do.—C XIV (Mal.), Anon.

Beg. natvā gaṇapatim devīm vācam ācāryakovidān /
Varāhamihirācāryam śrīsūryādinavagrahān //
gurum gurūttamam cāpi tathā sahṛdayān api /
pāramparyagatam śāstram *Horārtham* prakaṭīyate //
mūrtitve ... itin poruḷ—sa raviḥ vācam dadātu. aṅṅane ellāmirikkunna ravi namukkāyikkoṇṭu vākkine taruvonāka.

Ms. T. 133-D.

Do.—C XV (Skt. and Mal.), Anon.

Beg. bhūyobhiḥ paṭubhiḥ paṭudhiyām horāphalajñaptaye
śabdanyāyasamanviteṣu bahuśaḥ śāstreṣu dṛṣṭeṣv api /
horātantramahārṇavapratarane bhagnodyamānām aham
svalpam vṛttavicitram arthabaulam śāstraplavam prārabhe //

Ms. PM. 4385.

Do.—C XVI (Mal.), Anon.

Beg. mūrtitveti. sa raviḥ naḥ vācam dadātu. ā ravi namukku vākkine taruvūtāka. śaśabhṛtaḥ mūrtitve parikalpitaḥ= śaśabhṛttinṟe mūrttitvattiṅkal parikalpitanāyirunnoruttan. śaśabhṛttinṟe=candranṟe. mūrttitvattiṅkal=vṛttākāramāyirikkinṟa dehattiṅkal. paritaḥ=cuṭṭākāreṇa kalpitamāyirikkunna ...

Ms. PM. 4155-A.

Do.—C XVII (Mal.), *Horāvyākhyānam*, Anon.

Beg. sa raviḥ naḥ vācam dadātu. ā ravi namukku vākkine taruvūtāka. sarvaprakāśanāyi jñānasvarūpanāyiripporuttan...

Col. (C. 2226-A) : its horāśāstre Bṛhajjālaka-*Viṣamākṣaravivṛtau Prakāśikāyām Utpalāyām* Drekkāṇādhyāyaḥ pañcaviṁśaḥ.

Mss. 6551, 12974-B, L. 521.

Do.—C XVIII (Mal.), *Horāvyākhyānam*, Anon. Ms. 872-A.

Do.—C XIX (Mal.), Anon.

Beg. ā ravi praśna-jātaka-muhūrttādikaḷil satyayāyirikkunna vākkinettaruṭāka. sarvaprakāśanāyi jñānasvarūpanāyirikkinṭoruttan ādityan. candranṟe śarīramakakkalpiccirunnoruttan.

Ms. P. 999. Note. Related to C XVII, above.

Hora (contd.)

Do.– C XX (Mal.), Anon.

Beg. (Ch. 21) lagnattiṅkal ninnu putrakaḷatrabhamkaḷ śubhapati-prāptaṅṅaḷāyirikkumpoḷ ...

Ms. P. 996.

Do.—C XXI (Mal.), *Horāphalaratnāvali*, apocryphally attributed to Kaṇṇaśśa Paṇikkar.

Beg. Kaṇṇaśśan ennuḷḷa Paṇikkaraccan
khaṇḍiccu maṯṯuḷḷa mataṅṅaḷellām /
nirṇīta-*Horāphalaratna*sāram
varṇiccu collunniha śiṣyanoṭāy //
iviṭe kavi uṇṭākkān bhāviccirikkunna granthatte ...

Edn. Sri Rama Vilasam Press, Quilon, M.E. 1102. Ref. Ul. I. 350-51 ; Ul. Sup. I. 129.

Do.—C XXII (Mal. verse), by a pupil of Rāma. Men. in the beg. of the au.'s *Laghuhorāvivaraṇam* ; cf. :

rāṇaśāstraṅṅal kaṇṭiṭṭu rāṇāvṛttaṅṅaḷāl punaḥ /
'*Horāśāstram* camacciṭṭaṅṅāryāvṛttaṅṅaḷāl punaḥ //
Laghuhora camaykkunnen ...

Horāphalaratnāvali by Kaṇṇaśśa Paṇikkar : See *Horā*, C XXI.

Horābhiprāyanirṇaya by Parameśvara : Name of C VIII on *Horā*.

Horāsāra (jā.), Anon.

Beg. pāśāṅkuśa-svarada-cūtaphalam dadhānam ... (1) ;
jayati jagadekahetur viśvātmā ... (2) ;
nimiṣādivatsarāntam ... (3)

Mss. C. 226, C. 772, C. 2112-A, P. 1001 ; Ad.

Horāsāroccaya (jā.), by Acyuta Piṣāraṭi, in 7 chs. Mss. 8327-A, 8327-B (with C). Ref. Ul. II. 324.

Do.—C (Mal.), *Horātantram Paribhāṣa*, Anon. Ms. 8327-B.

Ref. Chirakkal T. Balakrishnan Nair, 'Horātantram Paribhāṣā', *Sāhitya Parishat Traimāsikam*, (Mal., Ernakulam), 5 (M.E. 1112) 417-20 and Ul. II. 651, where it is attributed to Acyuta Piṣāraṭi himself. For a refutation of this view, see K.V. Sarma, Intro. to his edn. of *Rāśigolasphuṭānīti*, p. 7.

X. **An Unidentified Astronomer.** About a dozen metrical tracts on different astronomical topics, couched in simple Malayalam verse, have been recorded, which, from their very similar narrative style and identical expressions, seem to be from the same pen, possibly, even sections of an extensive work which used to be studied individually and, so, are now generally found distributed in different mansucripts. Their author, however, prefers to remain anonymous. These works are as follows :

	Similar expression in the initial verse		
—*Gāṇitam-Bhāṣā* II (Mal.)	prakāram atha collinen		
—*Pañcabodha* IX ,,	Do.	Do.	Do.
—*Lātavaidhṛtādigaṇita* ,,	Do.	Do.	Do.
—*Sūryacchāyādigaṇita* I ,,	Do.	Do.	Do.
—*Candragaṇita* ,,	gaṇippān	iha	Do.
—*Candrasphuṭādigaṇita* II ,,	Do.	Do.	Do.
—*Sūryacandracchāyāgaṇita* ,,	Do.	Do.	Do.
—*Candrasphuṭādigaṇita* ,,	Do.	kriya	Do.
—*Śuddhacandārkagaṇita* ,,	Do.	Do.	Do.
—*Grahaṇagaṇita* X ,,	collunnuṇṭu	curukki	ñān
—*Chāyāgrahaṇagaṇita* II ,,	Do.	Do.	Do.
—C on *Vyatīpātavaidhṛta* ,,	Do.	Do.	Do.

ADDITIONS

Page 6 : **Acyuta II** : Acyuta Piṣāraṭi

Add : —C on *Sūryasiddhānta*

,, 21 : *Keralācārya*. See also below in Ch. VI.

,, 38 : **Citrabhānu-Śiṣya**

Add : —*Grahaṇāṣṭaka* III (?)

—*Praśnaprakāśikā* I (?)

—*Praśnabhāṣā* I (?)

—C IV on *Pañcabodha* II (?)

—C V on *Muhūrtapadavī* II (?)

,, 62 : *Praśnaprakāśikā* I

Add : By Citrabhānu-śiṣya (?). **Authorship.** Suggested on the basis of the characteristic *maṅgala-śloka.*

II

A BIBLIOGRAPHY OF KERALA-BASED ASTRONOMY AND ASTROLOGY

CHAPTER II

A BIBLIOGRAPHY OF KERALA-BASED JYOTIṢA LITERATURE

There exist, in regions outside Kerala, in Sanskrit and in other Indian languages, a considerable number of astrological texts which proclaim themselves as Kerala Jyotiṣa and, as such, might, in a way, be called 'Kerala-based jyotiṣa texts'. The possible origin, nature and major trends of these texts have been discussed briefly elsewhere in my *Kerala Astronomy*, pp. 38-40. These works can be identified by one or more of such indications as : (1) the definite mention of their non-Keralite authorship ; (2) the addition of the expression 'Kerala' to their titles, apparently intended to distinguish them from other regional or all-India texts of the same or similar titles ; (3) their high popularity ouside Kerala which is matched only by their being practically unheard of in Kerala, the reason for which is obviously that, in a conservative society, one would scarcely go in for a low-rate alien imitation or improvisation when the full original is with oneself. Most of these works are anonymous or ascribed to apocryphal authors. Some claim to be parts of larger works. It is but natural that, while manuscripts of these works occur in good numbers outside Kerala, indicating their popularity in trans-Kerala regions, in Kerala itself, their manuscripts are well-nigh absent. It is a moot point as to what extent these texts are indebted to Kerala Jyotiṣa in the matter of the their tradition, teachings or inspiration. In some cases, it might be regular borrowal, in others restricted to their nature and contents and in still others only to the ideas. In certain cases, it is even possible that Kerala has lent nothing more than its name ! The lack of definitive authorship and the amorphous nature of contents of some of these works, naturally, make their identification difficult. This is especially so, in the case of works which appear under different titles and in varied extent, a fact which is reflected in the following *Bibliography*, as well. Certain methods to ascertain the indebtedness of individual texts to Kerala Jyotiṣa and to pursue this interesting study have been suggested in my *Kerala Astronomy* (see p. 41).

In the following pages, an attempt has been made to document information about 'Kerala-based' Jyotiṣa works, in Sanskrit, from various sources, and present the same with suitable annotations and references about the availablity of manuscripts and editions thereof

but without any serious effort at the correlation of allied texts. The nature of the different texts is indicated by adding, after their titles, their subjects in abbreviation : 'kar.' for *Karaṇa*, 'jā.' for *Jātaka*, 'pra.' for *Praśna*, 'muh.' *Muhūrta*, 'astrol.' for General Astrology, 'nat. astrol.' for Natural Astrology, etc. The general abbreviations employed in the *Bibliography of Kerala Jyotiṣa literature*, above, have also been made use of, as necessary.

In the case of texts whose manuscripts, as available in the different manuscripts repositories, have been noticed in the *Catalogus Catalogorum* (CC) of Aufrecht or the *New Catalogus Catalagorum* (NCC), I-VI, of the Madras University, the CC or NCC references are given. And, in the case of texts which have not been noticed in the CC or the NCC, or which exhibit some peculiarity or other, they are referred directly to the relevant Manuscripts Catalogues or other sources, using The undermentioned additional abbreviations :

Lucknow, Skt. Parishad	*A catal. of Mss. in the Akhila Bharatiya Skt. Parishad, Lucknow*, compiled by Daulat Ram Juyal, Lucknow, Vos. I-II, 1963, 1969. (Ref. by vol. and pp.)
Mysore	*Cata. of Skt. Mss. in the Govt. Lib., Mysore*, and its Supplemental Cata., in 4 Pts., Mysore, 1922-1955 (Ref. by vol. and pp.)
Nepal Vir.	*Nepāla- Rājakīya-Vīraputakālayastha- Hastalikhita-Samasta-pustakānām Saṅkṣipta-sūcīptram*, Ed. Buddhi Sagara, Kathmandu, Sam. 2020. (Ref. by pp. and nos.)
Raj. Jaina	*Rājasthān kī Jaina Śāstra Bhanḍārom kī Granthasūcī*, Ed. by Kastur Chand Kasaliwal etc. Jaipur, Vols. I-IV, 1949-1962. (Ref. by vol. and pp.)
Raj. Jodh.	*A cata. of Skt. and Pkt. Mss. in the Rajasthan Or. Res. Inst. (Jodhpur Colection)*, ed. by Muni Jinavijayaji, Pts. I-III B, Jodhpur, 1963-68. (Ref. by vol. and pp.)
Varanasi	*A des. cata. of Skt. Mss. acquired aud deposited in the Skt. Univ. Lib. (Sarasvati Bhavana), Varanasi, during the years 1791-1950*, vols. I-XII, Varanasi, 1953-65. (Ref. by vol. and pp.)
V.V.R.I.	*Catalogue of V. V. R. I. Manuscript Collection*, in two Parts. ep. by Vishva Bandhu, Hoshiarpur, 1959. (Ref. by pt. and pp.)

BIBLIOGRAPHY OF AUTHORS AND WORKS

Akṣarakeralī or *Akṣarakevali* (pra) Mss. See NCC I (rev.), 11.

Akṣaracintāmaṇi (pra.) from *Keralamata* ascribed to Śiva. Ib., 12.

Akṣaracūḍāmaṇi (pra), related to *Keralapraśna* V attributed to Keralācārya. Ib.

Appāsūri, *alis* Nṛhari or Nṛsimha
 – C, *Śāradāgama*, on *Uḍudāyapradīpa*

Avajadapraśna or *Keralīpraśna*, from the *Rudrayāmala*, Ib., 412.

Uḍudāyapradīpa (jā.), described in some mss. as *Keralīgrantha* and *Keralīracita*. Mss. NCC II. 289-90. Ascribed to Keralācārya in Ms. Ker. 1521. Edn. with Tr., Royal Victoria Press, Madras, 2nd edn., 1900. For other edns., see NCC II 289.

Do – C I. Anon., Ib. 290.

Do.– C II, *Uddyota* by Bhairavadatta, son of Harirāma. Ib. Edn. Bombay, 1875 ; with Hindi C, Banaras, 1868.

Do.—C III, *Tattvadīpikā* by Jīvanātha Jhā, son of Śambhunātha. Ib.

Do.—C IV, *Śāradāgama* by Appāsūri *alias* Nṛhari or Nṛsiṁha. Ib.

Do.—C V, *Snehakūpikā* by Bālakṛṣṇa, son of Jyotiḥsvarūpa. Ib.

Do.—C VI, by Cola. Ib.

Do.—C VII, by Paramasukha. Ib.

Do.—C VIII, by Mayūreśvaropādhyāya. Ib.

Uḍupakerala (jā.), attributed to Prajāpati. Ib.

Kerala° : See also *Keralī°*, *Keraḷiya°*.

Kerala or *Keralī* (astrol.) Mss. NCC V. 43.

Keralagranthodāraharaṇa (astrol.), by Mūladeva, possibly a C on his *Keralapraśna*. Ib.

Keralacandrikā (jā.) Ib. (*Dvādaśabhāva*). See also *Keraladvādaśabhāva*.

Keralacintāmaṇi (astrol.) Ib.

Keralacūḍāmaṇi (pra.) See also *Keralapraśna* or *Divyacūḍāmaṇi* and *Cūḍāmaṇikeralī*.

Keralajātaka (jā.) NCC V. 43. See also *Keralīyam Jatakam*.

Keralajātakānanda or *Keralarahasya* : See *Keralarahasya*.

Keralajñāna or *Keralīyajñāna* (pra.) NCC V. 43. Some as *Keralapraśna*.

Keralajyotiṣa or *°jyautiṣa* (astrol.) Ib.

Keralatattva (astrol.) Ib.

Keraladīpikā I (astrol.) Men. in *Keralacandrikā*, Mad. D. 14026.

Keraladīpikā II (astrol.), by Krahā...śa, son of Cannayajvan, Ms. NCC V.43.

Keralanāḍi (astrol.) Ib.

Keraladvādaśabhāvaphala I (jā.), in verse. Ib.

Keraladvādaśabhāvaphala II (jā.), in prose. Ib.

Keralapañcapakṣī (prognostication), from *Svaravicāra*. Ib.

Keralapāśāvalī (prognostication), ascribed to Garga. Ib. See also *Pāśakakevalī*.

Keralapradīpa (astrol.). Ib. Possibly, *Jñānapradipa* or *Keralabṛndāvana* of Padmanābha.

Keralapraśna(grantha) I (pra.) Mss. NCC V.44 ; Varanasi, IX. 304.

Keralapraśna(grantha) II (pra.), ascribed to Garga. Ib.

Keralapraśna III (pra.) Invokes Kūṣmāṇḍi ; the last verse of the work describes the work as the *Pāśakakeralī* of Garga. Ib.

Keralapraśna IV (pra.), Prognostication with arecanuts. Ib.

Keralapraśna V or *Divyacūḍāmaṇi*, ascribed to Keralācārya. Related to *Akṣaracūḍāmaṇi* and *Cūḍāmaṇisāra*. Ib. Edn. in Telugu script with Telugu gloss, Vavilla Press, Madras, 1944 ; Banaras, Sam. 1731. See also *Cūḍāmaṇikerali*.

Keralapraśna VI or *Keralapraśnaprakaraṇa* or *Keralīyajñāna*, (pra. based on letters.) Ib.

Keralapraśna VII (pra.), in 67 verses. Ib. **Edn. with Hindi. Tr.,** Lakshmipur, Bombay, 1913.

Keralapraśnagrantha (pra.), by Mūladeva. Mss. NCC V.44.

Do.—C (?) *Keralagranthodāharaṇa*, by the author himself. Ib. 43.

Keralapraśnaḥ (pra.) Mss. Varanasi, IX. 288, 298.

Keralabayalis : Name of *Uḍudāyapradīpa* attributed to Keralācarya.

Keralabṛndāvana or *Jñānapradīpa* (astrol.), by Padmanābha. Mss. NCC V. 44.

Keralabhāgya (astrol.) Ib.

Do.—C. Ib.

Keralabhāṣya (astrol.), Ib. On *Keralavacanāni* (?)

Keralamata (astrol.), ascribed to Śiva : See *Akṣaracintāmaṇi*.

Keralamatapraśnasaṅgraha (pra.) by Mihirabhaṭṭa. Ms. VVRI I. 82.

Keralayātrā (nat. astrol.) Ms. NCC V. 45.

Keralayogāvalī (astrol.) Ib.

Keralaratnamañjarī (astrol.) by Viśvanātha Bhaṭṭa, Ib.

Keralaratnākara (astrol.) Ib.

Keralarahasya or *Keralajātakānanda* (astrol.), by Śukrācarya. Ib.

Keralarājayogasāra (astrol.) Ib

Keralavacanāni (astrol.) Ib.

Do.—C, *Keralabhāṣya*, by Ḍhuṇḍhirāja. Ib.

Keralaśāstra I (astrol.), Ib. 47; Varanasi, IX. 314. See also *Keralīśāstra*.

Keralaśāstra II, Sn. *Gargasaṁhitā* (pra.) NCC V.45.

Do.—C, *Gargamanoramā*. Ib.

Keralaśāstrasūtra (astrol.) attributed in one of its mss. to a demoness named Nikaṣā.

Do.—C. Ib.

Keralaślokasūtra (astrol.) Ib.

Keralasāra (astrol.) Ms. Varanasi, IX. 286.

Keralasiddhānta (pra.), couched in the form of a dialogue between the divine couple, Pārvatī and Parameśvara, Ref. Ul. Sup. I. 228.

Keralasūtra I (astrol.) Ms. NCC V.47.

Keralasūtra II (astrol.), ascribed to Marīci, Ib ; Varanasi, IX. 296.

Keralasūtra III (jā.), by Śrī (?). Ms. Mad. T. 1981 (d).

Tr. in *Missing links of Hindu astrology*, No. 11, Bombay, 1963.

Keralahorā (jā). Ref. Ul. Sup. I. 229.

Do—C by Sarvartu Paṇḍita, written at the instance of Gopāla, at Vijayanagar. Ms. NCC V. 47.

Keralācārya. Despite the Kerala tradition that he was the minister of a Kerala King, it is not unlikely that he is an apocryphal or non-Kerala author. See *Ker. Astron.* pp. 46-47.

—*Uḍudāyapradīpa*
—*Keralapraśna* V or *Divyacūḍāmaṇi*
—*Mātrācūḍāmaṇi*
—See also above, pp. 21-22.

Keralipraśna or *Avajādapaśna*, from the *Rudrayāmala*. NCC V. 48.

Keralī° : See also Kerala°.

Keralī I (astrol.) or *Kerala*. Ms. NCC V.43.

Keralī II (nat. astrol.) Ib. 48.

Keralī III (pra.) by Rāvaṇa. Ib.

Keralī IV (pra.), or *Pāśakeralī*, prediction based on throwing the dice, ascribed to Garga. Ib. See also *Pāśakakeralī*.

Keralīgrantha (jā.), or *Uḍudayapradīpa* or *Jātakacandrikā*, by Veṅkaṭeśa. Ib.

Keralīcūḍāmaṇi (pra.) Ib. See also *Keralapraśna* or *Divyacūḍāmaṇi*.

Keralī(ya)jātaka (jā.) Ib. See also *Keralajātaka* and *Keralīyam Jātakam*.

Keralī(ya)jñāna (pra.) Ib. See also *Keralajñāna*.

Keralīdaśāprakāra (jā.) Ib.

Keralīpraśna (pra.) Mss. Varanasi IX. 294, 302. See also *Keralapraśna*.

Keralīpraśnabhaṣa (pra.) Ms. Nepal Vir, 28.

Keralīpraśna(vicāra), (pra.) Ib. ; Nepal Vir, 28.

Keralīpraśnasaṅgraha (pra.) Mss. NCC V.48.

Keralīpraśnasāra (pra.) Ib.

Keralīya (jā.) Ms. Mad. T. 2233 (g) (*Jīvakādhyāya*).

Keralīyajātakasaṅgraha (jā.) Ms. Mysore, I. 332.

Keralīya(jyotiṣa) (jā.) Ms. Mad. T. 1623.

Keralīyajñāna (pra.) Mss. Tanjore, D. 11685, 24078. See also *Keralajñana*.

Keralīyanakṣatradaśāphala (jā.). Ms. NCC V.48.

Keralīyapraśna (pra.) Mss. Ib. ; Raj. Jodhpur, III-B. 508.

Keralīyapraśnaratna (pra.), by Nandarāma Paṇḍita.

Edn. with Hindi C, Lakshmi Venkatesvara Press, Bombay : Kalyan, 1923-24.

Keralīyapraśnaratnākara (pra.) Men. Ul. Sup. I. 228.

Keralīyabhāṣasāra (astrol.) s. NCC V. 49.

Keralīyasūtra (jā.) Ms. Mad. 1981 (d), on *dvādaśabhāva*.

Keralīyam Jātakam (jā.) Ms Mysore, I. 332.
See also *Keralajātaka*.

Do.—C. Ms. Mysore, I. 332.

Keralīyam jātakam (*Saṅgraha*) (jā.), Ms. Mysore, I. 332.

Keralīśakuna (omenology), ascribed to Vyāsa. Ms. NCC V.49.

Keralīśakunāvalī (omenology), by Bhañjana Miśra. Ib.

Keralīśāstra (astrol.) Ms. Nepal Vir. 28. See also *Keralaśāstra*.

Do.—C (Newari). Ms. Nepal Vir, 28.

Keralīsammatakoṣṭhiprakaraṇa (astrol.) Ms. NCC V.49.

Keralīsārasaṅgraha (astrol.). Ib.

Krahā ... śa, son of Canna Yajvan.

—*Keraladīpikā*

Garga

—*Keralapāśāvalī*

—*Keralapraśnagrantha*

—*Keralī* or *Pāśakeralī*, all related.

Cūḍāmaṇikeralī (pra.), Ms. IO 3126. See also *Keralapraśna* V or *Divyacūḍāmaṇi*.

Cūḍāmaṇisāra (pra.), by Lakṣmaṇa, a résumé of the *Divyacūḍāmaṇi* or *Keralapraśna* V of Keralācārya. Ms. CC I. 189.

Cola

—C (VI) on *Uḍudāyapradīpa*.

Jātakaratnāvali (*Keralīya*), (jā.) Ms. Raj. Jodh. II-B. 320.

Jīvanātha Jhā, son of Harirāma

—C *Tattvadīpikā* on *Uḍudāyapradīpa*

Jñānapradīpa (°*ka*, °*pikā*) : Same as *Keralabṛndāvana* by Padmanābha.

Ḍhuṇḍhirāja

—*Keralabhāṣya* on *Keralavacanāni*

Dvādaśbhāva(phala) : See *Keralacandrikā* and *Keraladvādaśabhāvaphala*.

Nandarāma Paṇḍita

—*Keralīya-praśnaratna*

Nikaṣā, a demoness

—*Keralaśāstrasūtra*

Nṛhari or Nṛsiṃha, alias Appāsūri

—C, *Śaradāgama*, on *Uḍudāyapradīpa*

Padmanābha

—*Keralabṛndāvana* or *Jñānadīpa* (°*paka*, °*pikā*)

—***Keralapradīpa*** **(possibly same as the above work)**

Paramasukha

- C on *Uḍudāyapradīpa*

Parahita (kar.), apparently by a Tamil astronomer, based on the Kerala Parahita school. Epoch : Kali-day 16,83,312 (A.D. 1507). Couched in corrupt Sanskrit.

Beg. harihāravidhikhecarān praṇatvā
kalidivasāt 'priyabālajātako'nāt /
bhavati hi varabhaumavārapūrvam
parahitakhaṇḍam iti bruvanti santaḥ //

gunkāraḥ kulam bhānoḥ ...

Ms. Tanjore D. 11719 (70 gr.)

Pāśakakeralī : See *Pāśkakevalī*.

Pāśakakevalī (prognostication by dice throw), sometimes spelt as *Pāśakakeralī*, *Pāśakevalī* or *Pāśakevalī*, attributed to Garga.

Mss. CC I. 336 ; Lucknow, Skt. Parishad, I. 232.

Pāśakevalī I or *Jñānabhāskara* (nat. astrol.) Ms. Raj. Jaina, IV.286.

Pāśakevalī II or *Keralapraśna* (pra.), by Garga. Mss. Raj. Jaina, II. 272 ; IV. 286 ; Raj. Jodh. II-B. 330 ; Tanjore D. 11496.

Do.—C *Ṭīkā*. Mss. Raj. Jodh., II-B. 330.

Prajāpati

—*Uḍupakerala*

Praśnakeralī (pra.), by Bhojarāja. Ms. Varanasi, IX. 50.

Praśnabhārgava-kerala (pra.). Ms. CC I. 358.

Praśnavidyā (pra.), from *Keralīya*. Ms. NCC V. 49.

Bālakṛṣṇa, son of Jyotiḥsvarūpa

—C, *Snehakūpikā*, on *Uḍudāyapradīpa*.

Bharagva-pañcangam (astrol.), by Vararuci IV.

End: ity evam *Bhārgavam nāma Pañcāngam Bhārgavoditam* |
viditvā manujo yas tu kurute kāryam anvaham ||

Col. iti *Vararuci-viracitam Bhārgavapraṇītam Pañcāngam* samāptam.

Ms. Mad. D. 14055.

Bhañjana Miśra

—*Keralīśakunāvalī*

Bhairavadatta

—C, *Uddyota*, on *Uḍudāyapradīpa*

Bhojarāja

—*Praśnakeralī*

Mayūreśvaropādhyāya

— C on *Uḍudāyapradīpa*

Marīci

—*Keralasūtra*

Mātracūḍāmaṇi (jā. ?), by Keralācārya. Ms. Imperial Museum (now in the Asiatic Soc., Calcutta), 10737.

Mihira Bhaṭṭa

—*Keralamata-praśnasangraha*

Mūladeva

—*Keralapraśnagrantha*

—*Keralagranthodāharaṇa*, possibly C on above.

Rāvaṇa

—*Keralī* (pra.)

Lakṣmaṇa

—*Cūḍāmaṇisāra*

Vararuci III, Tamil astronomer of Kanchipuram who adapted the Parahita system of Kerala astronomy in the Tamil region. *c*. 1300 A.D.

—*Vākyakaraṇa* or *Vākyapañcādhyāyī*

Vararuci III (contd.)

Ref. T. S. K. Sastri and K. V. Sarma, Intro. to *Vākyakaraṇa*, (Madras, 1962), pp. vi-ix.

Vararuci IV

—*Bhārgavapañcāṅga*

Vākyakaraṇa I or *Vākyapañcādhyāyī* (kar.), by Vararuci III. Basic manual of the Vākyapañcāṅga of the Tamil country. In five chapters devoted, respectively, to *Ravicandrarāhusphuṭa*, *Tārāgrahasphuṭa*, *Tripraśna*, *Grahaṇa* and *Udayāsta-mahāpātāḥ*.

Mss. See Intro. to edn. **Cr. Edn.** with detailed Intro., Summary of contents and Appendices, by T. S. Kuppanna Sastri and K.V. Sarma, K.S.R. Institute., Madras-4, 1962.

Do.—C I, *Laghudīpikā* or *Laghuprakāśikā* by Sundararāja.

Mss. See Intro. to edn. **Cr. Edn.** by T. S. K. Sastri and K.V. Sarma, with the edn. of the text, above.

Do.—C II, *Sundararājīya* or *Vāsanāprakāśikā* by Sundararāja, being more extensive than C I above.

Men. by the au. himself in his C I, edn., pp. 3, 21, 24, 49, 50, 107; See also the intro. to his C I :

śrī-Nīlakaṇṭhāṅghrinivistacetāḥ
śrī-Somadevānujighṛkṣayaiva /
vicitravākyair vivṛtam punaś ca
prakāśaye 'ham karaṇam laghīyaḥ /

Vākyakaraṇa II (*Prakṣiptādhyāya*) (kar.), ch. VI, in 37 interpolated verses. **Ms.** See edn. **Edn.** By T.S.K. Sastri and K.V. Sarma, as App. to the edn. of *Vākyakaraṇa*, above.

Vākyakaraṇa III, related to *Vākyakaraṇa* II. **Ms.** Ker. P. 955.

Viśvanātha Bhaṭṭa

—*Keralaratnamañjarī*

Veṅkaṭeśa, of the Kāśyapagotra, pupil of Acyuta I

—*Keraligrantha*, *Uḍudāyapradīpa* or *Jātakacandrikā*

—*Devakerala* of Acyuta II, redaction of Part II

Vyāsa

—*Keraliśakuna*

Śiva

—*Keraḷamata*

Śukra Ācārya

—*Keralajātakānanda* or *Keralarahasya* or *Śukrakerala*

Śukrakerala : See *Keralajatakānanda*.

Śrī (?)

—*Keralasūtra* or °*śāstra*

Sarvartu Paṇḍita, protégé of Gopāla of Vijayanagar.

—C on *Keralahorā*

Sundararāja, Astronomer of the Tamil country, resident of the banks of river Kāverī, son of Anantanārāyaṇa and protégé of Somadeva ; admirer and contemporary of Nīlakaṇṭha Somayāji, with whom he had correspondence on astronomical problems (see above, pp. 95-96, *Sundararāja-praśnottara* by Nīlakaṇṭha Somayāji).

—C I, *Laghudīpikā* or *Laghuprakāśikā* on *Vākyakaraṇa* of Vararuci III.

—C II *Sundararājīya* or *Vāsanāprakāśikā*, a more extensive C on *Vākyakaraṇa*

Ref. T. S. K. Sastri and K. V. Sarma, Intro. to *Vākyakaraṇa*, Madras, 1962.

Note. Since most of the works noticed above are anonymous, that fact is not indicated against each work with the symbol 'anon'. However, when the real or apocryphal author of a work is known, the fact is duly indicated.

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Lucknow, Skt. Parishad. See below, p. 106.

Mad. Madras, Govt. Or. Mss. Library. Nos. preceded by 'D' denote mss. described in its *Des. Cata. of Skt. Mss.* and those preceded by 'T' denote mss. described in its *Triennial Cata. of Mss. (Skt.)*

Mysore See p. 106.

NCC *New Catalogus Catalogorum : An alphabetical register of Skt. and allied works and authors*, by V. Raghavan, K.K. Raja, University of Madras, 1949 ff.

Nepal Vir. See below, p. 106.

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Raj. Jodh. See below, p. 106.

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Varanasi See below, p. 106.

V.V.R.I. See below, p. 106.

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GENERAL ABBREVIATIONS

arith.	Arithmetic
astrol.	Astrology (general)
astron.	Astronomy (general)
C	Commentary
ecl.	Eclipse
jā.	Jātaka
kar.	Karaṇa
Ker. (?)	Kerala authenticity doubtful
Mal.	Malayalam
Ms(s).	Manuscript(s)
muh.	Muhūrta
nat. astrol.	Natural astrology
pra.	Praśna
Skt.	Sanskrit
TSS	*Trivandrum Skt. Series*

Chapter III

SOME SALIENT FEATURES OF KERALA ASTRONOMY

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1. Introduction

Mathematics and astronomy are two of the scientific disciplines to which significant contributions have been made, down the centuries, by Kerala scholars. The land of Kerala, a narrow strip of territory tucked away between the Western Ghats and the Arabian sea, produced superb mathematicians from very early times. The fervour with which the sister science of astrology, in its different branches, was cultivated, had had the beneficial effect of promoting the study of mathematics and astronomy, for the latter provided the basic framework for the practice of the former. The social structure which confined mainly, to certain sections of the community, the study of these disciplines and the freedom from political or religious upheavals which Kerala enjoyed helped the uninterrupted development, here, of these sciences. As a result of all this, significant strides were made and a very large number of treatises came to be written, down to the 19th century, in these disciplines. However, only a fraction of these works have come down to us, the bulk having been lost on account of the ravages of time and the inclement climate of the land which had a highly detrimental effect on the palmleaf manuscripts on which these works had been inscribed. The highly conservative outlook of the custodians of extant manuscripts of these technical texts, the local Malayalam language in which many of these works have been composed or commented upon and the rather obscure Malayalam script used for writing the manuscripts have all stood in the way of a proper study and interpretation of these works in terms of modern mathematics and thereby institute a proper evaluation thereof. In fact, modern scientific studies on Kerala astronomy have been based mainly on just a handful of texts as have, so far, been made available in print, out of the few hundreds of texts still available in the form of manuscripts.

2. Spirit of enquiry

At the outset, a reference might be made to the mental outlook and spirit of enquiry that characterised Kerala astronomers and

mathematicians in their investigations. Parameśvara of Vaṭaśreṇi (*c.* 1360-1455), who revised the then prevailing *Parahita* system of computation and evolved new methods in his work entitled *Dṛgganita*,[1] makes a revealing statement in this regard, in the beginning of that work. He says :

dṛśyante vihagā dṛṣṭyā bhinnāḥ parahitoditāḥ /
pratyakṣadṛṣṭāḥ spaṣṭāḥ syur grahāḥ śāstreṣv itīritam //I.1.2 //

satkarmoditakālasya grahā hi jñānasādhanam /
aspaṣṭavihagaiḥ siddhaḥ kālaḥ śuddho na karmaṇi // 3 //

ye tu śāstravidas tadvad golayuktividaś ca te'ḥ /
sphuṭakhecaravijñāne yatnaḥ kāryo dvijair ataḥ // 4 //

sañcintyeti samālocya pūrvatantrāṇi yatnataḥ /
sphuṭayuktim khecarāṇām goladṛṣṭyā samīkṣya ca // 5 //

sphuṭakhecaravijñānam śiṣyair yaiḥ prārthitam dvijaiḥ /
tebhyo Dṛgganitam nāma ganitam kriyate mayā // 6 //

'(The positions of) the planets derived according to the *Parahita* (system of computation) are found to be different (from their actual positions) as seen by the eye. And, in authoritative texts (*śāstra*) it is said that (only) positions as observed (should be taken) as the true ones. (I. i. 2).

'(The positions of) the planets are the means of knowing the times specified for (the performance of) meritorious acts. (Here), times calculated from incorrect (positions of) planets will not be auspicious for those) acts. (3)

1. K. V. Sarma, *The Dṛgganita of Parameśvara*, Cr. ed. with Introduction, Hoshiarpur, 1963. Parameśvara is reputed to have made continuous astronomical observations for 55 years with the help of instruments : *Cf.* what Nilakaṇṭha Somayājin, who received instruction from Parameśvara, says in his *Āryabhaṭīya-bhāṣya* (Gola, 43) : *Parameśvarācāryeṇa punaḥ grahaṇa-grahayogādikam yantraiḥ pañcapañcāśad-varṣakālam samyak parīkṣitam. Āha caivam...*"*grahendrāḥ pañcapañcāśad-varṣakālaṣaḍantare*" etc. (*Trivandrum Skt. Ser.*, No. 185, p. 154).

'Hence, efforts should be made for knowing the true (positions of) planets by those who are learned in the sciences and by those who are experts in spherics. (4)

'Cogitating thus, and painstakingly studying the ancient texts and observing well the true positions of the planets according to the spherics, I am composing a manual on astronomy for the twice-born disciples who requested for a knowledge of the true (positions of the) planets'. (6).

3. Stress on observation and experimentation

An insight into the mediaeval astronomer's methodology, which consisted of prolonged and repeated observation, experimentation, recording of readings, checking of the values obtained from observation with those obtained by computation and the postulation of corrections (*saṁskāra*), in order to make computation correspond with observation, might be illustrated by certain statements which Parameśvara makes elsewhere. In his sub-commentary *Siddhāntadīpika* on the *Mahābhāskarīya-bhāṣya* of Govindasvāmin,[1] he has a long excursus on a number of eclipses which he had observed carefully and about which he had recorded the details, with a view to effecting necessary corrections to prevailing rules of computation or for formulating new rules therefor (*op. cit.*, pp. 321-32). He commences the said excursus with the statement that he had been observing eclipses from Śaka 1315 (A.D. 1393), that he had found the observed times to have always preceded the computed times and, so, the computations needed corrections :

'tithiviśva'-(1315)-same śāke prārabhya grahaṇam mayā |
anekam īkṣitam, teṣu bhinnaḥ kālo dṛśā sadā || 2 ||

pratyakṣakālas teṣu prāg gaṇitānītakālataḥ |
ataḥ kāryo 'tra saṁskāro yaḥ kaścid gaṇakottamaiḥ || 3 || (p. 321)

He then enunciates the True positions of the Sun, Moon, Moon's higher apsis and node at sunrise for a particular contemporary date as calculated by the application of the corrections proposed by him,

1. T. S. Kuppanna Sastri, Cr. ed. of *Mahābhāskarīya of Bhāskarācārya with the Bhāṣya of Govindasvāmin and the super-commentary Siddhāntadīpikā of Parameśvara*, Madras, 1957.

so as to form the zero-readings for calculations beginning from that date. He also suggests that verifications should be made in course of time and further corrections postulated and applied as and when needed :

asmin kāle tu ravīndūccapātānam sthitir īdṛśī |
etatsiddhyartham asmābhiḥ saṁskārāntaram ādṛtam || 91 ||

... ...

kālāntare tu saṁskāraś cintyatām gaṇakottamaiḥ ||93|| (p.332)[1]

4. Concern for accuracy

The concern of these astronomers for accuracy in the results of computations is reflected in a statement, again by the same author, in another work of his. Towards the close of an extensive work on the computation of eclipses, entitled *Grahaṇamaṇḍana*,[2] Parameśvara observes, in all humility, that the times of contact etc. as obtained through the calculations enunciated in that work *may, at times*, differ slightly from observed positions.[3] He hastens to add that these small differences must be due to factors which he could not take into account or which had not been identified thus far. But, as a practical scientist, he is confident that it would be possible to postulate, as a result of further observations and experimentations, the necessary corrections by the application of which even these small differences could be eliminated :

śāstrād alabdha ekaḥ saṁskāro grahaṇakarmaṇi ravīndvoḥ |
asty eveti ca kalpyaḥ gaṇakavarair yuktividbhir ataḥ || 98 ||
dṛṣṭvā bahūparāgān sañcintya ca golayuktim iha gaṇakaiḥ |
kalpyaḥ sa tu saṁskāras tasmād, athavā gurūpadeśena || 99 ||

5. Researcher's outlook

The endeavour among Kerala astronomers for continuous

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1. On Parameśvara's astronomical observations, see K. V. Sarma, 'Anpattiyañcu kollatte tapassu' ('Fifty-five years' penance'), *Mathrubhumi* (Malayalam Weekly, Kozhikode), 7.10.1956, pp. 29-30.

2. K.V. Sarma, *Grahaṇamaṇḍana of Parameśvara*, Cr. ed. with Introduction, Translation and Appendix, Hoshiarpur, 1965

3. *Cf.*, *Ibid.* : *kālo 'nena ca siddhaḥ kadācid api bhidyate svalpam ||66||*

efforts at improving their results is reflected in the enunciation by Parameśvara in a later work of his, *viz. Dṛggaṇita*, a correction to one of his earlier works, the *Grahaṇamaṇḍana*. This correction which is to be applied to the Mean positions of the Sun, Moon, Higher apsis and Node as calculated according to the *Grahaṇamaṇḍana* is given at the close of his *Dṛggaṇita*, II. 47-50, with the introductory statement :

kāryo graheṣu Grahaṇamaṇḍanokteṣv ataḥ param /

saṁskāras tam ca vakṣyāmi tatra noktam yato mayā // II. 47 //

6. Continuity of tradition

Still another significant characteristic of Kerala astronomy and mathematics relates to the regular continuity of traditional knowledge that was handed down from father to son or from teacher to disciple, in succession. Some of the known lines of tradition extend through several centuries. An old palmleaf document discovered and published by the present writer[1] records a line of tradition which extends from the 13th to the 17th centuries : Govinda Bhaṭṭatiri of Talakkuḷam (1237-95)→pupil : grandfather of Parameśvara (13th-14th cent.) → grandson-pupil : Parameśvara (*c.* 1360-1455) → son : Dāmodara (15th cent.) → pupil : Nīlakaṇṭha Somayāji (1444-1545) → pupil : Jyeṣṭhadeva (*c.* 1500-1600) → pupil : Acyuta Piṣāraṭi (1550-1621). Another similar astronomical chronology recorded in the *Āranmula-vilāsam Haṁsappāṭṭu* by Kṛṣṇan Āśān, author of *Bhāṣā-Jātakapaddhati*, carries the above-noted tradition to the beginning of the 19th century ;[2] Acyuta Piṣāraṭi (1550-1621) → pupil : Tṛppāṇikkara Potuvāḷ → pupil : Nāvāyikkuḷattu Āzhāti → pupil : Pulimukhattu Poṭṭi (1686-1758) →pupil : Rāman Āśān (18th cent.) → son : Kṛṣṇan Āśān (1756-1812) This line continues as follows : Kṛṣṇadāsa (1756-1812) → pupil : Dakṣiṇāmūrti Mūssatu of Maṅgalaśśeri, in Āranmuḷa (18th-19th cent.) → pupil : Bālarāman Piḷḷa of Nālēkāṭṭil family of Mānnār (19th cent.) → pupil : Prince Rājarāja Varma (Vidvān Karīndran Ceruṇṇi

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1. K.V. Sarma, 'Direct lines of astronomical tradition in Kerala', *Pt. Charudeva Shastri Felicitation Volume*, Delhi, 1972 ; 'Oru Jyotiṣa-granthavari (An astronomical document),' (in Malayalam), *Mathrubhumi* (Kozhikode, Kerala), 19.5.1957.

2. See Ulloor S. Parameswara Aiyar, *Kerala Sahitya Charitram*, (*History of Kerala literature*), Vol. II, (Trivandrum, 1954), pp. 321-22.

Koyittampurān of Kilimānūr) (1812-46).[1] The importance of the continuity of tradition in a practical, demonstrative discipline like astronomy, at a time when there was not a proliferation of printed books and public schools, is self-evident. And, the part played by these traditions in keeping alive the torch of astronomical enquiry in Kerala cannot be underestimated.

7. Basic features of Kerala astronomy

(a) *Adherence to the Āryabhaṭan system.* From at least the 7th century, if not earlier, Kerala had been the bastion of the Āryabhaṭan school of astronomy. While the view expressed in certain quarters that Āryabhaṭa hailed from Kerala[2] has yet to be substantiated, there is no doubt about the extensive popularity of this system in the land. The later Kerala schools are all based on the Āryabhaṭan system. Most of the known commentaries on the *Āryabhaṭīya* have been written by Kerala mathematicians. Well-nigh, every one of the scores of astronomical works produced in Kerala follow the *Āryabhaṭīya* basically. And, the efforts of Kerala mathematicians have generally been directed towards the revision, supplementation and correction of Āryabhṭan astronomy and mathematics with a view to deriving more accurate results.

(b) *Kaṭapayādi notation.* An extremely convenient method of expressing numbers through letters, known as the *Ka-ṭa-pa-yādi* notation, has been extensively used in Kerala from very early times. A legendary author named Vararuci is credited with this innovation and the authorship of the popular collection of *Candra-vākyas* or *Vararuci-vākyas* ('Moon computation sentences'), composed in this notation. The *Grahcāranibandhana* of Haridatta (A.D. 683) also uses this notation extensively. In this notation, each of the four series of consonants beginning with *k*, *ṭ*, *p*, and *y* in the Sanskrit alphabet stands for the digits 1 to 9. In conjunct letters, the value only of the final consonants is to be taken into account. Vowels following the consonants have no value. *n* and *ñ* and the pure vowels stand for zero.

1. *Ibid.*

2. For the latest essay in this direction, see K Damodaran Nambiar, 'Āryabhaṭan', *Mathrubhumi* (Malayalam Weekly, Kozhikode, Kerala). Oct. 18, 1970, pp. 15-16, 41.

The letter *ḷ*, which is peculiar to Dravidian denotes 9.[1] The versatility of the notation rests in the fact that even long and intricate numbers can be expressed through apparently meaningful expressions and verse-bits, facilitating their easy verification and memorisation.[2] The numerous sine and other mnemonic tables which form a characteristic feature of the Kerala School of astronomy are couched in this notation.

(c) *Basic principles.* In their mathematical work, Kerala authors and, for that matter, Indian authors in general, based themselves on the fundamentals of arithmetic, algebra, geometry and trigonometry. They were aware also of properties of numbers, to some extent. Calculus and higher mathematics, as developed in the West during the last three hundred years, were not known, but strict application of geometry, trigonometry and algebra, coupled with clear analytical thought and intuition, have enabled Kerala astronomers to arrive at important results and enunciate theorems which were later rediscovered in the West, some after several centuries.[3]

8. Parahita system of astronomy

A significant event in the annals of Kerala astronomy was the promulgation, in A. D. 683, of the *Parahita* system by Haridatta (*c.* 650-700) through his *Grahacāranibandhana*[4] and *Mahāmārga-*

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1. The simple rule for this notation is given by the verse :

na-ñāv acaś ca śūnyāni, saṅkhyāḥ ka-ṭa-pa-yādayaḥ |
miśre tūpāntahalsaṅkhyā, na ca cintyo halaḥ svaraḥ ||

Sadratnamālā of Śaṅkara Varman

2. See *e.g.*, the chronogram '*ācāryavāg abhedyā*' which is kali day 1434160, on which Śaṅkarācārya introduced certain reforms ; and the Moon-sentence, '*gīr naḥ śreyaḥ*' denoting 0°—12'—3''.

3. For a resume of the more important of these anticipations, see below, Ch. II.

4. Cr. ed with Intro. by K.V Sarma, K.S. Research Inst., Madras, 1954. On the discovery and identification of this thitherto unknown basic text of the *Parahita* system see K. V. Sarma, 'Parahita-gaṇitattinte mūlagrantham', *Mathrubhumi* (Mal. Weekly, Kozhikode), Oct. 10. 1954.

nibandhana.[1] The event is recorded in several later works. For instance, the *Sadratnamālā* of Śaṅkaravarman says :

> *ācāryāryabhaṭapraṇītagaṇitam prāyaḥ sphuṭam tat kalau*
> *'gotrottuṅga'-(3623)-mitābdake vyabhicaran brahmādisiddhāntake* /
> ... ...
> *dṛgvaiṣamyavaśāt 'mahāsthala'-(3785)-mite kalyabdake niścitaḥ*
> *saṁskāro vibudhair yataḥ parahitatvam teṣu vīneṣv ayam* // (6.1, 3)

'The astronomical treatise composed in Kali 3623 (A.D. 522) by Āryabhaṭa gave well-nigh accurate results, whereas the *siddhāntas* ascribed to Brahmā etc. had (by that time) tended to be inaccurate. (When its results too tended to be inaccurate, as exemplified by their) not tallying with observation, the correction called *Parahita* was adopted by the wise in Kali 3785 (A.D. 683) for the planets other than the Sun'.[2]

Tradition says that the inauguration of the system took place on the occasion of the twelve-yearly *Māmāṅkam* (*Mahā-magha*) festival held at Tirunāvāy on the Malabar coast.[3]

Haridatta based his system on the *Āryabhaṭīya*, but improved upon it in several ways. He made computation easier by specifying simple multipliers and divisors for the various calculations, including the derivation of the positions of the planets. His use of the *Kaṭapayādi* notation made his composition elegant. He introduced the unique system of enunciating graded tables of the Sines of the arcs of Anamoly and of Commutation of the different planets (*Manda-jyā* and *Śighra-jyā*) at intervals of 3° 45', to facilitate the computation of the true positions of the planets. His *Grahacāra-nibandhana* being only the computation manual of the system, deals,

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1. This seems to be the full-fledged theoretical treatise of the *Parahita* system while the *Grahacāranibandhana* is only its working manual. Manuscripts of this work have not yet come to light; the work is known through its reference by Haridatta himself in the *Grahacāranibandhana*. 3. 44.

2. For other references to this event and the identity of Haridatta and his works, see K.V. Sarma, *Grahacāranibandhana*, *op. cit.*, Intro., pp. v-ix.

3. See *ibid.*, pp. vi-vii; Ulloor S. Parameswara Aiyar, *Kerala Sahitya Charitram*, vol. I, (Trivandrum, 19_3), p. 165.

mainly, with the calculation of the Kali days elapsed, *tithi* and *nakṣatra* of any day, the mean and retrograde motion of the planets and their Mean and True positions. One of the corrections introduced by Haridatta to make Āryabhaṭan results more accurate, is called *Bhaṭa-saṁskāra* or *Śakābda-saṁskāra* (on account of its being calculated for the years beginning from the 'śakābda' of Āryabhaṭa, *viz.*, 444), and is particularly significant. This correction specifies that for every completed year after Śaka 444, a correction in minutes (*kalā*) of —9/85, —65/134, —13/32, + 45/235, + 420/235, —47/235, —153/235 and +20/235 should be made to the Mean positions of the Moon, Moon's apsis, Moon's node, Mars, Mercury, Jupiter, Venus and Saturn, respectively, no correction being necessary in the case of the Sun.[1]

A large number of astronomical manuals based on the *Parahita* system, including a *Grahacāranibandhana-saṅgraha*,[2] have come to be composed during later times, both in Sanskrit and in Malayalam, each taking off from a convenient contemporary epoch (*khaṇḍa-dina*) for which the True positions of the planets would have been fixed after elaborate calculations, these positions being used as zero-corrections for computation according to these manuals. Some of these incorporate also further corrections.

9. Dṛk system of astronomy

The *Dṛk* system promulgated by Parameśvara of Vaṭaśreṇi (*c.* 1360-1455), through his *Dṛggaṇita*,[3] is, as pointed out above (§2), a revision of the *Parahita* system and was composed with a view to make the results of computation accord with observation. While no new methodology is enunciated here, new multipliers and divisors are given for the derivation of the Kali days and for the calculation of the Mean positions of planets. Minute corrections are given

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1. The verse giving this correction reads as follows :

'vāgbhāvo' (444) nāc chakābdāt dhana-śata-laya-hān manda-vailakṣya-rāgair
āptābhir liptikābhir virahitatanavaś candra-tattuṅga-pātāḥ /
śobhā-nīrūḍha-saṁvid-gaṇaka-nara-hatān māgar-āptāḥ kujādyāḥ
saṃyuktā jñāra saurā virahitatanukau jīvaśukrau, na bhānoḥ //

2. Ed. K. V. Sarma, as Appendix to the edn of *Grahacāranibandhana*, Madras, 1954.

3. Cr. ed. by K.V. Sarma, with Intro. V.V.R. Inst., Hoshiarpur, 1963.

for these positions after long periods of time. Revised values are given for the positions of planets at zero Kali. Also, the values of the sines of arc of Anomaly (*Manda-jyā*) and of Commutation (*Śīghra-jyā*) are revised and given for intervals of 6 degrees.[1]

As in the case of the *Parahita* system, a large number of manuals have come to be composed following the *Dṛk* system, both in Sanskrit and in Malayalam. The results obtained through this system being more accurate, this system was used for horoscopy (*jātaka*), astrological query (*praśna*) and the computation of eclipses (*grahaṇa*), while the *Parahita* continued to be used for fixing auspicious times for rituals and ceremonies (*muhūrta*). In order to cater to both the purposes, some of the later manuals have dealt with both the *Dṛk* and *Parahita* systems.

1. On Parameśvara and the *Dṛk* system in general, see Intro. to *Dṛggaṇita*, *op. cit.*, pp. x-xiii. See also, K.V. Sarma. 'Parameśvara's *Dṛggaṇita*', *Mathrubhumi* (Kozhikode), Aug. 28, 1960, pp. 19-21.

CHAPTER IV

ANTICIPATION OF MODERN MATHEMATICAL DISCOVERIES BY KERALA ASTRONOMERS

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1. The background

In the light of the trends that developed in the study and practice in Kerala of the twin sciences of astronomy and mathematics, as indicated in the last chapter, it need not be surprising that some of the significant findings of modern mathematics are found anticipated in the astronomical works produced during the mediaeval times in that region. In their endeavour to make the results obtained by computation accord with observation, the Āryabhaṭan school of astronomers of this corner of India made substantial advancement in their computational skill. Working on the basic principles of algebra, geometry and limiting values, they produced, by dint of shrewd thinking and logical reasoning, coupled with a fund of intuition, significant results on such matters as the reduction to the ecliptic, summations and associated integrations leading up to the value of π etc. Especially, the achievements connected with π were brought to the notice of scholars by Charles M. Whish who presented a paper on the subject before the Royal Asiatic Society in 1832.[1] Among other things, Whish set out in this paper the several formulae enunciated in four Keralite works on astronomy and mathematics, *viz.*, *Tantrasaṅgraha*, *Yuktibhāṣā*, *Karaṇapaddhati* and *Sadratnamālā*, for the circumference of a circle in terms of its diameter and transformations of the infinite series for π associated with the name of Leibnitz.

The significance of the findings of Whish was hardly taken note of by historians of mathematics or of Indian literature, for more than a century. Instead, the view continued to prevail that Indian astronomy and mathematics were mostly borrowed from the West and that, at least since Bhāskara II, little original contribution was made by India to

1. C.M. Whish, 'On the Hindu quadrature of the circle, and the infinite series of the proportion of the circumference to the diameter exhibited in the four Śāstras, the *Tantrasamgraham*, *Yucti-bhāshā*, *Carana Padhati* and *Sadratnamālā*', *Trans. Royal Asiatic Soc. of Gr. Britain and Ireland*, 3 (1835) 509-23.

these disciplines.[1] The credit for launching, in the 1940-s, a detailed study of the discoveries of Whish in terms of modern mathematics goes to Prof. C.T. Rajagopal and his students and colleagues, including K. Mukunda Marar, A. Venkataraman, T.V. Vedamurthi Aiyar and K. Balagangadharan. The valuable notes added by Rama Varma Maru Thampuran and A.R. Akhileswara Aiyar to their excellent edition of the First Part of *Yuktibhāṣā*, (Trichur, Kerala, 1948), an expository work in Malayalam, new light on whose date and authorship has recently been thrown,[2] is another significant contribution in this direction. More recently, some other scholars like T. S. Kuppanna Sastri, T. A. Saraswathi and R.C. Gupta have been making valuable contributions to connected topics. The attempt made herein below to present, in a succinct form, the results of the investigations of the said scholars and those of the present writer which lie scattered in different books and periodicals, will, it is to be hoped, give a bird's-eye view of the significant contributions of Kerala savants to mathematics and astronomy.

2. Tycho Brahe's Reduction to the ecliptic

In astronomical computations, the longitude of a planet is measured along the ecliptic, while, in fact, its motion takes place along its own orbit which, generally, deviates slightly from the ecliptic. For an accurate computation of the planet's position this deviation has to be taken into consideration. In the West, it was

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1. *Vide*, for instance, G.R. Kaye: "After the time of Bhāskara (born A D. 1114), no Indian mathematical work of historical value or interest is known." (*Indian mathematics*, Calcutta, 1915, p. 24); A. B. Keith: "After Bhāskara, no progress can be recorded in Indian astronomy." (*A history of Indian literature*, Oxford, 1929, p. 523); A. A. Macdonell: "The last eminent Indian astronomer was Bhāskarācārya, born in A.D. 1114." (*A history of Sanskrit literature*, Indian rep., Delhi, 1962, p. 370); D. Arka Somayaji, "Bhāskara is the last name in the field. Barring a number of commentators, no name worthy of mention is there in India subsequent to Bhāskara." (*A critical study of the ancient Hindu astronomy*, Dharwar, 1971, p. 3). Standard historians of mathematics like Cantor, Cajori and D.E. Smith, too, hold the same view. The first Western historian of mathematics to take note of Whish's findings would appear to be A. P. Juschkewitsche in his *Geschichte der Mathematic Mittelalter*, (Leipzig, 1964), as pointed out to C. T. Rajagopal by D. T. Whiteside, the eminent Cambridge authority on Isacc Newton.

2. K. V. Sarma, 'Jyeṣṭhadeva and his identification as the author of *Yuktibhāṣā*', *Adyar Library Bulletin*, 22 (1958) 35-40.

the Danish astronomer Tycho Brahe (1546-1601) who enunciated a formula for this 'Reduction to the ecliptic'.[1]

In India, a formula for this Reduction was enunciated, for the first time, by a contemporary Kerala astronomer Acyuta Piṣāraṭi (1550-1621), author of *Rāśigola-sphuṭānīti* ('Computation of True longitude on the celestial sphere')[2] and several other works on astronomy. Acyuta gives his formula for this reduction in the case of the moon in his work entitled *Sphuṭanirṇaya* ('Computation of true longitudes of planets') in the following verse :

pātonasya vidhos tu koṭibhujayor jīve mithas tāḍayet
antyakṣepaśarāhatam vadhaṃ amum vikṣepakoṭyā haret |

labdham vyāsadaloddhṛtam himakare svarṇam, vipāte vidhau
yugmāyugmapadopage ; vidhur ayam spaṣṭo bhagole bhavet ||

'Multiply the tabular cosine (*koṭijyā*) and sine (*bhujājyā*) of the moon-minus-node and the product by the tabular versine (*śara*) of the maximum latitude (*antya-kṣepa*) of the moon. Divide this by the tabular cosine of the latitude at the particular moment and the quotient is to be divided again by the tabular radius (*vyāsadala*). The result (will give the correction for longitude which) is to be added to or subtracted from the moon's longitude, as the moon-minus-node is in an even or an odd quadrant, respectively. The True Moon measured on the ecliptic is thus got'.[3]

Acyuta's formula may be expressed in terms of modern mathematics thus : 'If F is the longitudinal difference between the node and the planet, w the maximum latitude and y the actual latitude, then, the correction $k = \sin F . \cos F (1 - \cos w) / \cos y$.[4]

1. *Vide* his *Astronomiae instauratae Progymnasmata*, Vol. I, Prague, 1602.

2. K. V. Sarma, *The Rāśigolasphuṭānīti*, (On the calculation of true longitude on the celestial sphere and Reduction to the ecliptic in Indian astronomy), Critical ed. and Tr. with Introduction, Adyar Library and Res. Centre, Madras, 1955.

3. This verse has been extracted by the author in his *Rāśigola-sphuṭānīti*, verse 47, *op. cit.*, p. 29.

4. For a demonstration of the correctness of this formula in terms of modern mathematics, see K.V. Sarma, *op. cit.*, Introduction, pp. 10-13.

In another of his works, *viz. Uparāgakriyākrama* ('Procedures in the computation eclipses'), Acyuta gives also a simplified version of the said formula.[1]

The actual date of composition of the *Sphuṭanirṇaya*, which is the earliest work to enunciate the reduction formula, is not known, but it is definitely before 1583 which is the date of composition of the *Uparāgakriyākrama* which contains the simplified formula.[2]

3. Newton-Gauss Interpolation formula

It has been demonstrated in detail that Indian mathematics employed, in its search for better results, improved rules of interpolation, by using the second differences and that a particular case, upto the second order, of the more general Newton-Stirling interpolation formula was known to Brahmagupta (*c* A.D. 625).[3] Following this line of thought, the Kerala astronomer Govindasvāmin (*c*. 800-850) has enunciated a set of rules for the computation of intermediary functional values, different formulae being laid down for different augmental intervals:

gacchad-yāta-guṇāntaravapur yātaiṣya-diṣvāsanac-
chedābhyāsa-samūha-kārmukakṛti-prāptāt tribhis tāḍitāt /
vedaiḥ ṣaḍbhir avāptam antyaguṇāje rāśyoḥ kramād antyabhe
gantavyāhata-vartamāna-guṇajāc cāpāptam ekādibhiḥ //

antyād utkramataḥ krameṇa viṣamaiḥ saṅkhyāviśeṣaiḥ kṣiped
bhaṅktvāptam, yadi maurvikāvidhir ayam makhyāḥ kramād vartate
śodhyam vyutkramatas tathākṛtaphalam...

(*Bhāṣya* on *Mahābhāskarīya*, 4.22)[4]

'Multiply the difference of the last and the current sine differences by the two parts of the elemental arc (made by any intermediary point on it) and divide by the square of the elemental arc and further multiply by three. Now divide the result so obtained by four in

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1. For a demonstration of this formula, see *ibid.*, pp. 13-14.

2. On the chronology of these works, see *ibid.*, pp. 14-15.

3. R. C. Gupta, 'Second order interpolation in Indian mathematics upto the fifteenth century,' *Indian Jl. of Hist. of Sc.*, 4 (1969) 86-98.

4. *Mahābhāskarīya* of Bhāskarācārya, with the *Bhāṣya* of Govindasvāmin and the super-commentary *Siddhāntadīpikā* of Parameśvara, ed. by T.S. Kuppanna Sastri, Madras, 1957, pp. 201-2.

the first *rāśi*, or by six in the second *rāśi*. The final result thus obtained should be added to the portion of the current sine difference (got by linear proportion).

'In the last (third) *rāśi*, multiply the linearly proportional part of the current sine difference by the remaining part of the elemental arc and divide by the elemental arc. Now, divide the result (so obtained) by the odd numbers (1, 3, 5 etc.) according as the current sine difference (is first, second, third etc.), when counted from the end in the reverse order. Add the final result thus obtained to the portion of the current sine difference (got by ordinary proportion). These are the rules for computing true sine differences for (direct) sines. In the case of versed sines, apply the rules in the reverse order and the above corrections are to be subtracted from the respective differences (got by linear interpolation)'.[1]

Using the general functional notation and finite difference operator, the rule for the second *rāśi* may be put as :

$$f(x+nh)=f(x)+n\Delta f(x)+\frac{n(n-1)}{2}\{\Delta f(x)-\Delta f(x-h)\}$$

which is a particular case (up to the second order) of the general Newton-Gauss interpolation formula.[2]

4. Taylor series for Sine and Cosine functions

The approximations for sine and cosine functions up to the second power of small quantities, following from a well-known series expansion due to the British mathematician Brook Taylor (1685-1731)[3] may be expressed as :

$$f(x+\theta)=f(x)+\theta f'(x)+\frac{\theta^2}{2!}f''(x)\ldots$$

(approximately, when θ is small)

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1 For the rationale of this formula, see R.C. Gupta, *ib.*, pp. 91-92.

2. E. Whittaker and G. Robinson, *Calculus of observations*, London, 1965, p. 37.

3. W.W.R. Ball, *A short account of the history of mathematics*, Dover reprint, New York, 1960, pp. 380-81. But see C. B. Boyer, *History of mathematics*, Wiley, 1968, p. 422.

This approximation has been anticipated, in its particular cases, $f(x)=\sin x$ and $f(x)=\cos x$, by more than three hundred years, by Mādhava of Saṅgamagrāma (*c.* 1340-1425)[1] in the following verses :

iṣṭa-doḥkoṭidhanuṣoḥ svasamīpasamīrite /
jye dve sāvayave nyasya kuryād ūnādhikam dhanuḥ //
dvighna-tal̤liptikāptaikaśaraśailaśikhīndavaḥ /
nyasyācchedāya ca mithas tatsaṁskāravidhitsayā //
chitvaikām prakṣipej jahyāt taddhanuṣyadhikonake /
anyasyām atha tām dvighnām tathā 'syām iti saṁskṛtiḥ /
iti te kṛtasaṁskāre svaguṇau dhanuṣas tayoḥ //[2]

'Placing the (sine and cosine) chords nearest to the arc whose sine and cosine chords are required, get the arc difference to be subtracted or added. For making the correction, 13,751 should be divided by twice the arc difference in minutes and the quotient is to be placed as the divisor. Divide the one, (say sine), by this (divisor) and add to or subtract from the other (*i.e.*, cosine), according as the arc difference is to be added or subtracted. Double this (result) and do as before (*i. e.*, divide by the divisor). Add or subtract the result (so obtained) to or from the first sine or cosine to get the desired sine or cosine chords'.[3]

5. Newton's Power series for the Sine and Cosine

In Western mathematics, Newton (1642-1727) is credited with

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1. On Mādhava, his date and works, see K. V. Sarma, Introduction to his edition of the *Veṇvāroha of Saṅgamagrāma Mādhava*, (Sanskrit College Trippunithura, Kerala, 1965), and his paper on 'The date of Mādhava, a little-known Indian astronomer *Quarterly Jl. of the Mythic Soc.*, **49** (1958) 183-86.

2. Quoted by Nīlakaṇṭha Somayājin in his commentary on the *Āryabhaṭīya* Gaṇita., 12, (edn. Trivandrum, 1930, pp. 54-55), with the prefatory statement : *tatrāha Mādhavaḥ*.

3. For this translation and its rationale in terms of modern mathematics, see R.C. Gupta, 'Second order of interpolation in Indian mathematics up to the fifteenth century', *Indian Jl. of Hist. of Sc.*, 4 (1969) 92-94. For a traditional elucidation, see commentary by Śaṅkara Vāriyar on Nīlakaṇṭha's *Tantrasaṅgraha*, II, 10-13 (edn. Trivandrum, 1953, pp. 19-20) and *Yuktibhāṣā, op. cit.*, pp. 168-71.

the enunciation, in about 1670,[1] of the sine and cosine power series, which might be stated as :

$$\sin x = x - \frac{x^3}{3!} + \frac{x^5}{5!} - \ldots$$

$$\cos x = 1 - \frac{x^2}{2!} + \frac{x^4}{4!} - \ldots$$

These formulae are implied in the following verses of Mādhava, depicting the derivation of the series of sine and tabular versine (*śara*) values of the arc correct to 1/3600 of a degree :

nihatya cāpavargeṇa cāpam tattatphalāni ca |
haret samūlayugvargais trijyāvargahataiḥ kramāt ||

cāpam phalāni cādhodho nyasyoparyupari tyajet |
jīvāptyai, saṅgraho 'syaiva vidvān-ityādinā kṛtaḥ ||

nihatya cāpavargeṇa rūpam tattatphalāni ca |
hared vimūlayugvargais trijyāvargahataiḥ kramāt ||

kintu vyāsadalenaiva dvighnenādyam vibhājyatām |
phalāny adhodhaḥ kramaśo nyasyoparyupari tyajet ||

śarāptyai, saṅgraho 'syaiva stenastrī-tyādinā kṛtaḥ |

'Multiply repeatedly the arc by its square and divide by the square of the even numbers (2, 4 etc.) increased by that number and then multiplied by the square of the radius. Place the arc and the results (of the above operation) one below the other and subtract each from what is above it. (This is the method) to derive the arcs, which are collected (and stated, in order, in the mnemonic verse) beginning with the expression *vidvān* (*i.e.*, 0° 0′ 0″ 44‴ stated in the *kaṭapayādi* notation).

'Multiply repeatedly the unit measurement, (which is the radius), by the square of the arc and divide by the square of the even numbers

1. Moritz Cantor, *Vorlesungen uber Geschichte der Mathematik*, 2nd edn., Vol. III, cited by C T. Rajagopal and A. Venkataraman in their paper on 'The sine and cosine power series in Hindu mathematics', *Jl. of the Royal As. Soc. of Bengal*, (Science), 15 (1949) 1-13, fn. on p. 1.

(2, 4 etc.) decreased by that number and then multiplied by the square of the radius; the first is, however, to be divided by twice the radius. Place the results one below the other and subtract each from the one above it. (This is the method) to derive the *śara-s* (tabular versines of the arc) which are collected (and stated, in order in the mnemonic verse) beginning with the expression *stena* (i.e., 0° 0′ 0″ 6‴).[1]

These verses, taken with certain statements occurring in the *Yuktibhāṣā* (pp. 183-90) and in the *Karaṇapaddhati* (IV. 12-13) lead one directly to Newton's sine and cosine formulae. Though positive proofs are still wanting about the authorship of the above verses which explain the derivation of the sine and *śara* values enumerated in the mnemonical verses beginning with *vidvān* and *stena* which are definitely known to be composed by Mādhava, it is very likely that he himself is the author of these verses also.[2] But whatever that be, since he he has derived the values *vidvān* etc., it but logical to presume that he knew also the method therefor.

6. Infinite G.P. Convergent series

The credit for enunciating in India, for the first time, a formula for the sum of an infinite convergent geometrical progression, goes

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1. For an exposition of these verses and a demonstration of the procedure described, see *Yuktibhāṣā*, *op. cit.*, Notes on pp. 183-93. See also *Karaṇapaddhati*, ed. with com. in Malayalam by P. K Koru. (Cherp, Kerala, 1953), pp. 199-207. For a detailed exposition of the rationale of the method, see C.T. Rajagopal and A. Venkataraman, *ibid.*; T. A. Saraswathi, 'Development of mathematical ideas in India', *Indian Jl. of Hist of Sc.*, 4 (1969) 75-76.

2. While quoting these verses in their Notes, the editors of *Yuktibhāṣā* give the source as *Tantrasaṅgraha*, but without any further reference (see *op. cit.*, p. 190), and other scholars have followed this lead (see, e g., C. T. Rajagopal, *ib.*, p. 2). But these verses, as also several others similarly quoted by the editors of the *Yuktibhāṣā*, do not occur in the *Tantrasaṅgraha* (vide edn. of the work, Trivandrum, 1958). T. A. Saraswathi says that "the *Tantrasaṅgraha* published from the Trivandrum University (*sic*) seems to contain one part only of the text. The editors of the *Yuktibhāṣā* had access to the complete MS. in the Trippunithura Skt. College Library, I am informed." (Fn. 9 on p. 234 of the *Bul. of the National Inst. of Sc.*, No. 21 (1962). This information is not likely to be correct. The Trivandrum edition of *Tantrasaṅgraha* is, in fact, complete in itself. The second part of the Trippunithura MS. is likely to be another astronomical work written in continuation of *Tantrasaṅgraha*.

to Nīlakaṇṭha Somayāji (born 1444). This he gives in his *Āryabhaṭīya-Bhāṣya*, while explaining the process of deriving the arc of a circle in terms of the chord by means of a computation which involves the summing up of an infinite convergent G.P. series : *evam yas tulyaccheda-paramabhāga-paramparāyā anantāyā api saṁyogaḥ, tasya anantānām api kalpyamānasya yogasya ādyāvayavinaḥ parasparāṁśacchedād ekonacchedāṁśasādhyam sarvatrāpi samānam eva.* (*Bhāṣya* on *Āryabhaṭīya*, Gaṇita. 17, edn., Trivandrum, 1930, p. 106). 'Thus the sum of an infinite series, whose later terms (after the first) are got by diminishing the preceding one by the same divisor, is always equal to the first term divided by one less than the common mutual divisor.'

In continuation of this enunciation, Nīlakaṇṭha elaborately demonstrates it for a finite G.P. and also for an infinite decreasing G.P.[1]

7. Lhuiler's formula for the Circum-radius of a Cyclic quadrilateral

In Western mathematics, the eighteenth century mathematician Lhuiler is credited with the discovery, in 1782, of an expression for the circum-radius of a cyclic quadrilateral.[2] In India, however, we find the same formula enunciated by the Kerala astronomer Parameśvara (*c.* 1360-1455) in his commentary on the *Līlāvatī*, in the following lines :

doṣṇām dvayor dvayor ghātayutānām tisṛṇām vadhāt |
ekaikonetarattraikyam catuṣkavdhabhājitam ||

labdhamūlena yadvṛttam viṣkambhārdhena nirmitam |
sarvam caturbhujakṣetram tasminn evāvatiṣṭhate ||

'The three sums of the products of the sides, taken two at a time, are to be multiplied together and divided by the product of the sums of the sides taken three at a time and diminished by the fourth. If a circle is drawn with the square root of this quantity as radius, the whole quadrilateral will be situated inside it.'

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1. On this, see T.C. Saraswathi, 'The development of mathematical series in India', *Bul. National Inst of Sc. of India*, No. 21 (1962) 320 ff.; see esp. pp. 325-26.

2. *Vide* D.E. Smith, *History of mathematics*, Boston, 1925, vol. II, p. 286.

Thus, if a, b, c, d are the sides and r the circum-radius,

$$r=\sqrt{\frac{(ab+cd)(ac+bd)(ad+bc)}{(a+b+c-d)(b+c+d-a)(c+d+a-b)(d+a+b-c)}}$$

The rationale of this formula has been given in the 16th cent. Kerala commentary *Kriyākramakarī* on the *Līlāvatī*.[1]

8. Gregory and Leibnitz's Series for the Inverse tangent

The power series for arc tan x. which was enunciated for the first time in the United Kingdom in 1671 by the Scottish mathematician James Gregory (1638-75) and in Europe in 1673 by the German mathematician and philosopher Gottfried Wilhelm Leibnitz (1646-1716), in the case of $x=1$, may be stated as follows : In the case of infinite series of powers of x representing an arc of a circle of unit radius which subtends at the centre of the circle an angle whose tangent (x) does not exceed unity,

$$\text{arc tan } x=x-\frac{x^3}{3}+\frac{x^5}{5}-\ldots(|x|\leqslant 1)$$

In India, this series was enunciated by Mādhava of Saṅgamagrāma (1350-1410), nearly three centuries before it was discovered in the West. Mādhava's enunciation of the formula is contained in the following lines :

iṣṭajyā-trijyayor ghātāt koṭyāptam prathamam phalam |
jyāvargam guṇakam kṛtvā koṭivargam ca hārakam ||

prathamādiphalebhyo 'tha neyā phalakṛtir muhuḥ |
eka-tryādy-ojasaṅkhyābhir bhakteṣv eteṣv anukramāt ||

ojānām saṁyutes tyaktvā yugmayogam dhanur bhavet |
doḥ-koṭyor alpam eveha kalpanīyam iha smṛtam |
labdhīnām avasānam syān na tathāpi muhuḥ kṛte ||[2]

'Obtain first the result of multiplying the *jyā* (of a given *dhanus*) by the *trijyā* and dividing the product by the *koṭi* (of the *dhanus*). Multiply

1. On this, see T.A. Saraswathi, 'Development of mathematical ideas in India', *Indian Jl. of. His. of Sc.*, 4 (1969) 69.

2. Quoted in the Keralite commentary *Kriyākramakarī* on Bhāskara II's *Līlāvatī*, kāṇḍa 2, vṛtta. 40. These lines have been quoted also in the *Yuktibhāṣā* where a geometrical proof for it is given (see *op. cit.*, pp. 113-16).

this result by the square of the *jyā* and divide the square by the *koṭi*. Thus we obtain a second result, (as also) a sequence of the further results by repeatedly multiplying by the square of the *jyā* and dividing by the square of the *koṭi*. Divide the terms of the sequence in order by the odd numbers 1, 3, 5, etc.; after this, add all the odd terms and subtract from them all the even terms (without disturbing the order of the terms). Thus is obtained the *dhanus* whose two elements are the given *jyā* and *koṭi*. Here, the smaller of the two elements should be taken as the *jyā*, since, otherwise, the series obtained will be non-finite (in value).'

According to the above formula, if R is the radius and s and c are the sine and cosine chords of the arc,

$$\text{the arc} = \frac{sR}{c} - \frac{sR}{3c}\cdot\frac{s^2}{c^2} + \frac{sR}{5c}\,\frac{s^4}{c^4} - \ldots$$

which is Gregory's general series for arc tan x.

Mādhava's verses quoted above have been extracted and explained in the *Yuktibhāṣā* (*op. cit.*. pp. 113-16) in the traditional manner and its rationale demonstrated in terms of modern mathematics by C.T. Rajagopal and others.[1] Rajagopal's demonstration throws up, *inter alia*, certain interesting anticipations of Kerala mathematicians. Thus, after giving the general derivation of Gregory's series according to the *Yuktibhāṣā* and offering the proof therefor, Rajagopal observes: "There are two points which emerge from a consideration of the mathematical text presented here. In the first place, it employs relations which would appear not to have been noticed in Europe before modern forerunners and followers of the calculus started investigations.........Our second point is not unconnected with the first. The Hindu mathematicians achieved, without the aid of calculus, results which, for us, are treated best by means of the calculus.[2]

1. C. T. Rajagopal and T V. Vedamurthi Aiyar, 'On the Hindu proof of Gregory's series', *Scripta Math*, 17 (1951) 65-74; K. Mukunda Marar and C.T. Rajagopal, 'On the quadrature of the circle', *Jl. of the Bombay Br. of the RAS* (NS) 20 (1944) 65-82; T.A. Saraswathi, 'Development of mathematical series', *ibid.*. 'Development of mathematical ideas', *ibid.*

2. "This is not to gainsay the fact that (i) the Hindus' proof of Gregory's series shows their awareness of the principle of integration as we ordinarily use it nowadays; (ii) their intuitive perception of small quantities like $O(1/n^p)$, $n \to \infty$, in a certain role, is as good as a practical knowledge of differentiation."

But the Europeans who first explored the possibilities of expressing a circular arc as an infinite series, deliberately employed the calculus to guide them."[1]

9. Leibnitz's Power series for π

In modern mathematics, the irrationality of π was demonstrated, for the first time, by Lambert in a paper read before the Berlin Academy in 1671. It is interesting to note that nearly two centuries prior to this, Nīlakaṇṭha Somayāji (1444-1545) stressed the same point when he expressed himself in his *Bhāṣya* on the *Āryabhaṭīya* (Gaṇita. 10) to the effect that it is impossible to measure the circumference of a circle in exact terms of its diameter; it could be stated only approximately (*āsanna*).[2] What is more significant, is that, after elaborating the point further, he quotes anonymously an earlier authority to the same effect, which means that the fact had long been recognised in Indian mathematics.[3]

The enunciation of the value of π as a particular case of the power series for arc tan x, due to Leibnitz (1673), is explicitly: $\pi/4 = 1 - 1/3 + 1/5 - \ldots\ldots$

This formula has been anticipated by Mādhava of Saṅgamagrāma (1350-1410) while enunciating a method for the circumference of a circle, in the following verse:

vyāse vāridhi-nihate rūpahṛte vyāsasāgarābhihate /

tri-śarādi-viṣamasaṅkhyā-bhaktam ṛṇam svam pṛthak kramāt kuryāt //[4]

'Multiply the diameter by 4. Subtract from it and add to it alternately the quotients obtained by dividing four times the diameter to the odd integers 3, 5 etc.'

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1. Mukunda Marar and Rajagopal, 'On the Hindu quadrature of the circle', *ibid.*, p. 68.

2. *Cf.*: *āsannaḥ... kutaḥ punaḥ vāstavīṃ saṅkhyām utsṛjya āsannā eva ihoktā ? ucyate. tasya vaktum aśakyatvāt. kutaḥ ? yena mānena mīyamāno vyāso niravayavaḥ syāt, tenaiva mānena mīyamānaḥ paridhiḥ punaḥ sāvayava eva syāt ... niravayavatvam tu na labhyam iti bhāvaḥ.* (edn. Trivandrum 1930, Pt. I, pp, 41-42).

3. *Cf.*: *ata evāhuḥ—"kṛtakānityavad vyāsa-paridhī niyatau mithaḥ"*, *ibid.*, p. 42.

4. Quoted in the *Kriyākramakarī* (*op. cit.*), with the prefatory statement; *atrāha Mādhavaḥ ... ito'pi laghutaraparidhyānayanopāyaḥ amunaivoktam, yathā*, com. on *Līlāvatī*, kāṇḍa 2, vṛtta., 40).

For a circumference C of a circle of diameter D, this gives the formula : C, (*i.e.*, π D)=4D—4D/3+4D/5......or $\pi/4=1+1/3-1/5$......[1]

10. Approximations to the value of π

Continuing his enunciation of the circumference of a circle, as given above, Mādhava goes on to give a rational approximation to its value and, through it, the value of π :

yatsaṅkhyayī 'tra haraṇe kṛte nivṛttā hṛtis tu jāmitayā |
tasyā ūrdhvagatāyās samasaṅkhyā taddalam guṇo 'nte syāt ||

tadvargai rūpahato hāro vyāsābdhighātataḥ prāgvat |
tasyām āptam svamṛṇe kṛte dhane śodhanañ ca karaṇīyam |
sūkṣmaḥ paridhiḥ sā syāt bahukṛtvo haraṇato 'tisūkṣmaś ca ||

'Let the process stop at a certain stage, giving rise to a 'finite sum'. Multiply four times the diameter by half the even integer subsequent to the last odd integer used as divisor and then divide by the square of the integer increased by unity. The result is the correction to be added to or subtracted from our 'finite sum', the choice of addition or subtraction depending on the sign of the last term in the sum. The final result is the circumference determined more accurately than (that obtained) by taking a large number of terms, *i.e.*, terms going beyond the stage at which we stopped.'

The formula enunciated here, which gives the value of π to an advanced degree of accuracy, may be expressed thus :

$$C \doteqdot 4D\left\{ 1-\frac{1}{3}+\frac{1}{5}-\ldots\pm\frac{1}{n}\mp\frac{(n+1)/2}{(n+1)^2+1}\right. \text{ where } n \text{ is large.}$$ [2]

$$\therefore \frac{\pi}{4}=1-\frac{1}{3}+\frac{1}{5}-\ldots\pm\frac{1}{n}\mp\frac{(n+1)/2}{(n+1)^2+1}$$

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1. For a detailed demonstration, see : *Yuktibhāṣā, op. cit.*, pp. 99, 11?-13 : C.T. Rajagopal, T.V. Vedamurthi Aiyar, K. Mukunda Marar. *ibid.*, P.K. Koru, *Karaṇapaddhati*, *op. cit.*, pp. 166-67.

2. For a demonstration of this formula, see Rajagopal, Vedamurthi Aiyar, Mukunda Marar, *ibid.*, P.K. Koru, *ibid.*, pp. 176-79 ; *Yuktibhāṣā*, *op. cit.*, pp. 120-23.

A still better correction is suggested by Mādhava in the following lines :

asmāt sūkṣmataro 'nyo vilikhyate kaścanāpi saṁskāraḥ |
ante samasaṅkhyādalavargas saiko guṇaḥ, sa eva punaḥ ||
yugaguṇito rūpayutaḥ samasaṅkhyādalahato bhaved hāraḥ |
triśarādiviṣamasaṅkhyāharaṇāt param etad eva vā kāryam ||[1]

'A correction still more precise is being stated here. The multiplier is the square of half the even integer (next greater than the last odd-interger divisor) increased by unity. This multiplier multiplied by 4, then increased by unity, and then multiplied by half the even-integer (already defined), is the divisor. This correction may be applied after the division by the odd integers 3, 5 etc. (indicated in the previous method and the same method of calculation followed).'

This formula which gives a still more accurate value of π may be expressd thus :

$$C \doteq 4D\left\{1-\tfrac{1}{3}+\tfrac{1}{5}-\ldots\pm\frac{1}{n}\mp\frac{\left(\frac{n+1}{2}\right)^2+1}{\left[\left(\frac{n+1}{2}\right)^2\cdot 4+1\right]\left(\frac{n+1}{2}\right)}\right\}$$

$$\frac{\pi}{4}=1-\tfrac{1}{3}+\tfrac{1}{5}-\ldots\pm\frac{1}{n}\mp\frac{\left(\frac{n+1}{2}\right)^2+1}{\left[\left(\frac{n+1}{2}\right)^2 4+1\right]\left(\frac{n+1}{2}\right)}$$

where n is odd and large.[2]

Elsewhere, Mādhava gives a series for π, different from that of Leibnitz. Thus, in continuation of the formula for the inverse tangent given in the lines *iṣṭajyātrijyayor ghātāt* etc. (see above, p. 20), he mentions the measure of the circumference when the arc calculated is half of circumference. thus :

vyāsavargād ravihatāt padam syāt prathamam phalam |
tadāditas trisaṅkhyāptam phalam syād uttarottaram ||

1. Quoted in the *Kriyākramakarī* on *Līlāvatī*, kāṇḍa 2, vṛtta., 40.

2. For its demonstration, see *Yuktibhāṣā*, *op. cit.*, pp. 136-39.

rūpādyayugmasaṅkhyābhir hṛteṣv eṣu yathākramam |
viṣamāṇām yutes tyaktvā samam hi paridhir bhavet ||

'Multiply the square of the diameter by 12 and extract the square root of the product. That is the first term. Divide the first term by 3 to obtain the second, the second by 3 to obtain the third and so on and thus get further terms. Divide the terms, in order, by the odd numbers 1, (3, 5) etc. Add the odd-order terms to and subtract the even-order terms from the preceding. The result will give the circumference'.[1]

The above enunciation gives the following formula for the circumference :

$$C\ (i.e., \pi D) = \sqrt{12D^2} - \frac{\sqrt{12D^2}}{3\cdot 3} + \frac{\sqrt{12D^2}}{5\cdot 3^2} - \frac{\sqrt{12D^2}}{7\cdot 3^3} \ldots$$

$$= \sqrt{12}D\left\{1 - \frac{1}{3\cdot 3} + \frac{1}{5\cdot 3^2} - \frac{1}{7\cdot 3^3} \ldots\right.$$

$$\pi = \sqrt{12}\left\{1 - \frac{1}{3\cdot 3} + \frac{1}{5\cdot 3^2} - \frac{1}{7\cdot 3^3} \ldots\right.$$

It would be interesting to derive from Mādhava's above-noted value of π, the following relation between circumference and diameter given by him :

vibudha-netra-gaj-āhi-hutāśana-
tri-guṇa-veda-bha-vāraṇa-bāhavāḥ |
nava-nikharva-mite vṛtivistare
paridhi-mānam idaṁ jagadur budhāḥ ||[2]

1. For an exposition and demonstration of these verses, see *Yuktibhāṣā*, *op. cit.*, pp 114-19 ; Marar and Rajagopal, 'On the Hindu quadrature of the circle', *ibid.*, p. 78 : P.K. Koru, *op. cit.*, pp. 203-6.

2. Quoted in the *Kriyākramakarī*, on *Līlāvatī*, kāṇḍa 2, vṛtta. 40, with the prefatory statement : *Mādhavācāryaḥ punaḥ ato 'pyāsannatamam paridhimānam uktavān.*

That is, for a diameter of 10^{11} the circumference is 28,27,43,33,88,233. The value of π from this, correct to eleven decimal places, would be 3.14159265359, which accords closely with the modern value of π, which is 3.14159265.

Using the above relationship of the diameter and the circumference, Mādhava has derived the 24 mahajyās (accurate sign-chords) which he has depicted in the mnemonic beginning with *śreṣṭham nāma variṣṭhānām* (0°—224′—50″—22‴).[1] It has also been verified that the value of the radian assumed by Mādhava in this evaluation corresponds to 3437′—44″—48‴—22⁗, which is remarkably close to its modern approximation, *viz.*, 3437′.74677078 = 3437′—44″—48‴—22⁗, 49.[2]

Rajagopal and his colleagues have drawn attention to and demonstrated, in terms of modern mathematics, a large number of further rational approximations of π which are found enunciated in later works like *Yuktibhāṣā*, *Karaṇapaddhati* and *Sadratnamālā*,[3] for most of which there are no exact parallels in Western mathematics. These approximations had been obtained by the application of various corrections, presumably in the form of continued fractions, on partial sums of the infinite series for $\pi/4$. Indeed, the enunciation of these corrections speaks volumes about the fervour with which mediaeval mathematicians of Kerala attacked this fascinating problem and the success they achieved therein, some of their enunciations anticipating

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1. For the full enunciation of these *mahā-jyās* of Mādhava and their rationale, see *Yuktibhāṣā*, *op. cit.*, pp 195-98 ; P.K. Koru, *op. cit.*, pp. 203-6.

2. See Rajagopal and Venkataraman, 'The sine and cosine power series in Hindu mathematics', *JRASB* (Sc.), 15 (1949) 3.

3 For these enunciations and their traditional expositions, see : Nilakaṇṭha Somayāji's *Bhāṣya* on the *Āryabhaṭīya*, Gaṇita, 9-12 (edn., Trivandrum, 1930), Pt. I, pp 40 ff.; *Yuktibhāṣā*, *op. cit.*, pp. 72-142 ; *Kriyākramakarī* on the *Līlāvatī* 2, vṛtta. 40, and *Karaṇapaddhati*, *op. cit.*, pp. 173-88. And, for their demonstration in modern terms see, Marar and Rajagopal and Vedamurthi Aiyar, 'On the Hindu proof of Gregory's series', *Scr. Math.* 17 (1951) 65-74 ; Rajagopal and Vedamurthi Aiyar, 'A Hindu approximation to Pi', *Scr. Math.* 18 (1952) 25-37 ; T.A. Saraswathi, 'The development of mathematical series in India', *Bul. of the National Inst. of Sc. of India*, 21 (1962) 320-43.

Western discoveries by nearly three hundred years. The same may be said with justification in the case of certain of their other mathematical contributions also. A competent and critical analysis, in terms of modern mathematics, of the writings of Kerala astronomers and mathematicians, the bulk of which still remains locked up in old palmleaf manuscripts. written in Malayalam script, may be expected to throw welcome light on the advances, down the centuries, made in these disciplines, in one remote corner of India.

11. Some other highlights

In the context of the continuity of astronomical tradition and the diligence with which its traditional exponents cultivated its study, a reference might be made here to certain other significant methodologies evolved and discoveries made by Kerala astronomers and methematicians. The introduction of the *Kaṭapayādi* notation and the expression of astronomical data through mnemonic tables and verses composed with the help of this facile notation has already been noticed. In his table of sine-differences enumerated in the verse *makhi-bhakhi* etc. (*Gītikā* 10), Āryabhaṭa gives only their rough values, correct to the minute. It is interesting that Govindasvāmin (*c.* 800-50) developed their evaluation still more accurately, correct up to the second order of sexagesimal fractions, *viz.*, seconds and thirds, which he gives in his *Bhāṣya* on *Mahābhāskarīya*. He also gives a formula for the derivation of the value of the last sine-difference when the tabular interval is halved. Developing the topic further, he enunciates also a rule for computing, from a given last sine-difference, the other sine-differences lying between 60° and 90°.[1]

The *Kuṭṭākāra-gaṇita*, which is a complex type of calculation involving the Rule of three, Indeterminate equations and Continued fractions, has been developed by Kerala mathematicians to a high degree. It enabled them to solve various problems which require the application of higher algebra according to modern working. Śaṅkaranārāyaṇa (c. 825-900) quotes in his commentary on the *Lahgubhāskarīya* (*op. cit.*, pp. 95-97) a short disquisition on the subject from *Govindakṛti*,

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1. See *Mahābhāskarīya* with Govindasvāmin's *Bhāṣya*, *op. cit.*, ch 4, verse 22, pp. 201-2. For an exposition of these rules and their rationale, see R.C. Gupta, 'Fractional parts of Āryabhaṭa's sines and certain rules found in Govindasvāmin's *Bhāṣya* on the *Mahābhāskarīya*', *Indian Jl. Hist. of Sc.* 6 (1971) 51-59.

a lost work of Govindasvāmin, while the later works like *Yuktibhāṣā* (16th cent.) give full accounts of the processes involved.[1] Nīlakaṇṭha Somayāji (1444-1545) has made significant contributions including logical proofs and demonstrations to geometrical theorems, a formula for the sum of an infinite, geometrically progressing convergent series, and the rationale for the formula for the sum of a geometrical progression. He has also offered geometrical demonstrations for the sum of an arithmetic progression, the sum of triangular numbers and the sums of squares and cubes of natural numbers.[2]

1. See *Yuktibhāṣā*, ch. 5, *op. cit.*, pp. 54-71. For the rationale of *Kuṭṭākāra* according to modern mathematical terms, see *ibid.*, Appendix, pp. xli-lxi.

2. See for details, T.C. Saraswathi, 'The development of mathematical series in India', *Bul. of the National Sciences of India*, No. 21 (1962) 320-43.

CHAPTER V

MAJOR TRENDS IN KERALA LITERATURE ON JYOTIṢA

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1. Introductory

The extensive Jyotiṣa literature produced in Kerala, in Sanskrit and in Malayalam, which latter is the regional language of that part of India, comprise of original treatises, expositions of individual topics, commentaries on standard texts, computation manuals, minor tracts, single verses and manifold mnemonic tables. A good part of the shorter tracts and other secondary literature which do not form full-fledged works have been lost and what survives of this type of literature has to be looked for in flyleaves and end folios of codices where such matter is generally found written. The definitive literature, too, has been affected considerably. The full extent of the literary activity in this line is not adequately known, much less recognised, for reasons of subject, script and language, as already mentioned above. However, an idea of this literary production can be judged from an examination of the surviving literature, a documented Inventory of which is given in Ch. II, above. While the said Inventory is expected to include references to all the works and authors that could be identified, special notice might be taken here of the broad trends and nature of the literature produced in this discipline. In order that the picture of Kerala Jyotiṣa might be presented in full, the accounts given below and in the Inventory are not restricted to astronomy and mathematics but made to include also the allied discipline of astrology which constitutes the applied aspect of astronomy.

2. The Classical texts

Some scholars have claimed that the foremost Indian astronomer, Āryabhaṭa hailed from Kerala. Though this claim yet remains to be fully authenticated, the popularity of the *Āryabhaṭīya* among Kerala astronomers is apparent from the profusion of manuscripts of that work recorded from that region[1] and from as may as eleven commentaries on it,

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1. Out of about 120 manuscripts of *Āryabhaṭīya* recorded in the *New Catalogus Catalogorum of Sanskrit and allied works and authors*, Vol. II, (Madras, 1966), p. 171, as many as 85 are from Kerala.

in Sanskrit and Malayalam, written by Kerala astronomers, the more important among them being those composed by Sūryadeva Yajvan, Parameśvara of Vaṭaśreṇi, Nīlakaṇṭha Somayāji and Ghaṭīgopa.[1] Two other texts of the Āryabhaṭan school, *viz.*, the *Laghubhāskarīya* and the *Mahābhāskarīya* of Bhāskara I,—of which, too, most of the recorded manuscripts are from Kerala,—have been equally popular in the land. There are seven Keralite commentaries on the former, by Śaṅkaranārāyaṇa, Sūryadeva Yajvan, Parameśvara, Udayadivākara and Śaṅkaran Nampūtiri, the other two being anonymous. The latter work has five Keralite commentaries, including those by Govindasvāmin, Sūryadeva Yajvan and Parameśvara. The other classical astronomical texts which were popular in Kerala are the *Sūryasiddhānta* which claims three Kerala commentaries and the *Laghumānasa* of Muñjāla, which has at least four Kerala commentaries The most popular textbook on mathematics has been the *Līlāvatī* of Bhāskara II, for which at least a dozen commentaries, besides several other works based on it, have been recorded. On the side of horary astrology, the *Horā* or *Bṛhajjātaka* of Varāhamihira enjoyed the greatest popularity; about twenty commentaries on this work by Kerala authors have been identified; besides these, there are also several abridgements and adaptations of that work. On the same subject, the *Jātakakarmapaddhati* of Śrīpati, which has three Kerala commentaries, had also been quite popular and in *Praśna* (Astrological query), the pride of place goes to *Praśnaṣaṭpañcāśikā* of Pṛthuyaśas with two Kerala commentaries.

3. Major works on Astronomy

A number of original texts on astronomy, dealing with all the main topics of the subject, have been identified. Some of them, like the *Tantrasaṅgraha* of Nīlakaṇṭha Somayāji, the *Tantrasāra* of Nārāyaṇa of Peruvanam and the *Sadratnamālā* of Śaṅkara-Varman, belong to the *tantra* type of treatises which take the beginning of the Kali era as the starting point for astronomical calculations. The bulk of the original texts are, however, of the *karaṇa* type, which use some convenient contemporary date as the epoch for starting the calculations enunciated by them, a device made use of by modern astronomers as well. This date is so chosen that at the ending moment of that day, *i.e.*, at the beginning (sunrise) of the next day, the Mean Moon (*Candra*) and

1. For details of the manuscripts, editions, extent, dates, and available studies on these works, as also of other works that might be referred to here-in-below, see Ch. V, 'Inventory of Kerala Jyotiṣa'.

Mean Higher Apsis (*Candra-tuṅga*) are in the same position or very close to each other, so that the days accumulated up to the epoch (called *Khaṇḍa-dina* or *śodhya-dina*) could be subtracted in 'full' from the current *Kali-dina*. The Mean positions of the Sun, Moon and other planets etc. are determined very accurately for the epoch and the readings so obtained are used as zero corrections for all computations for any date after the epoch. The *Grahacāranibandhana* of Haridatta, the basic *karaṇa* text of the *Parahita* system of astronomy, however, uses the date of Āryabhaṭa as the epoch, and the *Dṛggaṇita* of Parameśvara, the basic text of the *Dṛk* system, uses the beginning of Kali as its epoch. Some of the *karaṇa* texts are mere manuals giving rules for specific astronomical computations while some others like the *Karaṇapaddhati* of Putumana Somayāji, are fullfledged textbooks on the subject. Among the more important *karaṇa* texts may be mentioned the *Karaṇāmṛta* of Citrabhānu, which has three commentaries, the *Karaṇasāra* with commentary, possibly, by Śaṅkara Vāriyar pupil of Nilakaṇṭha Somayāji, the anonymous *Karaṇadarpaṇa* with three commentaries, *Karaṇottama* of Acyuta Piṣāraṭi with two commentaries, of which one is by the author himself, the anynomous *Laghukālārpaṇa* and the anonymous *Kriyāsaṅgraha*, with two commentaries. Several *karaṇa* texts have the generic title *Pañcabodha*. A dozen of them have been identified in the Inventory in Ch. V. Most of these are anonymous and only three of the authors could be identified, they being Putumana Somayāji, Puruṣottama and Kṛṣṇadāsa. These *Pañcabodha-s* have been very popular with the almanac-makers of the land and some of these claim commentaries, as well. The *Pañcabodha-s* generally contain five sections dealing with five astronomical topics. The topics treated are not, however, always the same. Thus *Pañcabodha* IV deals with *Vyatīpāta*, *Chāyā*, *Mauḍhya*, *Śṛṅgonnati* and *Grahaṇa*, while *Pañcabodha* II deals with *Tithi*, *Vāra*, *Nakṣatra*, *Yoga* and *Karaṇa*. Again, to deal with only five topics is not always the rule in these works; the number of topics dealt with could be less or more than five. For instance, *Pañcabodha* V or *Pañcabodhaśataka* of Puruṣottama, in 100 verses, contains only two sections and *Pañcabodha* I is in ten sections, dealing with *Tithinakṣatra*, *Vākyadhruva*, *Madhyama Sphuṭakriyā*, *Lāṭavaidhṛta*, *Mauḍhya*, *Sūryacchāyā*, *Somacchāyā*, *Śṛṅgonnati* and *Grahaṇa*. The *Bhadradīpagaṇita* of Iṭakramañceri Nampūtiri and the *Gaṇitasāra* or *Pañcabodha-gaṇitasāra* of Śaṅkaran Nāmpūtiri of Mahiṣamaṅgalam, both in Malayalam, are also comprehensive treatises.

Several of the *karaṇa* texts are smaller tracts devoted only to one or two topics like *Vyatīpāta*, *Vaidhṛta*, *Chāyā*, *Sphuṭakriyā* etc,

Three amongst these topics, *viz.*, Computation of the Moon, Eclipses and Shadow, seem to have attracted the special attention of Kerala astronomers and, as a result, a large number of manuals have come to be composed on these subjects. Some of these works attempt also at evolving new processes, offer new corrections and give the rationale to the procedures adopted. Most of these texts are anonymous.

4. Computation of the Moon

The fact that the calculation of the exact *tithi* (lunar day) and *nakṣatra* (asterism) at any moment depends upon the accurate knowledge of the Moon at that moment and that all the three, *viz.*, *tithi*, *nakṣatra* and Moon, are always required for the fixation of social and religious functions, in horoscopy and in the computation of eclipses etc. is enough to explain the importance given to the computation of the Moon. But the fast motion of the Moon, amounting to about 13 degrees a day, and the consequent quick change of its position during the same day, required special consideration in its correct computation. A good number of *karaṇa* texts, devoted specifically for the computation of the Moon, have, therefore, been composed. Among the more important manuals of this type may be mentioned the *Candra-sphuṭagaṇita* with a commentary and a super-commentary, *Candra-sūryasphuṭa-gaṇita*, *Candra-sphuṭādi-gaṇita*, *Śuddha-candra-kriyā-gaṇita*, *Śrāddha-candrādi-gaṇita* and *Sūkṣma-candra-sphuṭādi-gaṇita*, all anonymous.

5. Veṇvāroha method for the Moon

Of all heavenly bodies, the Moon has not only the fastest motion, but also the maximum changes in its velocity during the same day. Therefore, the computation of the Moon at some intermediate time during the day, if calculated on the basis of its true position and motion at sunrise or at sunset, as advocated in some *Pañcabodha* texts, would not give accurate results. An ingenious but facile method for the determination of the Moon at any time of the day with high accuracy has been evolved by the 14th century Kerala astronomer Mādhava of Saṅgamagrāma in his work called *Veṇvāroha*. He has also enunciated accurate moon-mnemonics, correct to the seconds, for being used in the *Veṇvāroha* method. His method seems to have caught the fancy also of later astronomers who have extended the method further to yield still more accurate results. At least four later works of this genre have been identified, they being *Candra-*

sphuṭāpti, *Veṇvārohakriyā* and *Dṛg-Veṇvārohakriyā*, all anonymous, and *Veṇvārohāṣṭaka* of Putumana Somayāji.

6. Computation of Eclipses

A branch of astronomy in which intense investigations have been made by Kerala astronomers refers to the computation of eclipses. The phenomenon of eclipses seems to have been exploited fully towards verifying calculations, instituting corrections and devising new methodologies. A reference has already been made to Parameśvara of *Dṛggaṇita* fame who has recorded the details about a large number of eclipses which he had computed, observed and also suggested corrections to correlate the two. Apart from minor tracts, a number of texts on the computation of eclipses have come down. These include three works having the common title *Uparāgakriyā-krama*, the first by Nārāyaṇa with commentary, the second by Acyuta Piṣāraṭi, with two commentaries, and a third, which is anonymous ; an *Uparāgaviṁśati* with commentary ; *Grahaṇamaṇḍana* by Parameśvara ; six anonymous works with the common title *Grahaṇa-gaṇita* ; four works under the title *Grahaṇāṣṭaka*, one of which is by Parameśvara and the others anonymous ; and the three works, *Candra-graha-gaṇita*, *Candra-sūryoparāga-gaṇita* and *Sūrya-grahaṇa-gaṇita*, all anonymous. Two works on eclipses which deserve special mention are the *Grahaṇa-nyāya-dīpikā* of Parameśvara, which discusses the rationale of eclipse-computation, and the *Grahaṇa-granthādi* by Nīlakaṇṭha Somayāji, which is an elaborate disquisition on the tradition and rationale of computing eclipses etc.

7. Computation of the Shadow

Computation of the positions of the Sun and the Moon from the Shadow (*Chāyā*) caused by them and vice versa had practical utility in the social and religious life of the people of mediaeval times. Besides calculations made on the basis of the *Śaṅku* (gnomon), intrinsic calculations involving the *Mahācchāyā* (Great Shadow or Sine Zenith distance) and the *Mahāśaṅku* (Great gnomon or Sine Altitude) had been developed in this behalf. Some of the *Pañcabodhas* and other *karaṇa* texts mentioned above have sections devoted to Shadow computation. Besides these, several independent works devoted solely to this subject have also been produced. Among the works of this category may be mentioned five different works, all entitled *Candracchāyā-gaṇita*, one of these being by Parameśvara, another by

Nīlakaṇṭha Somayāji and the others anonymous; two of these works have also commentaries. Other works on the subject include the *Chāyāgaṇita, Chāyāgraha-gaṇita, Chāyādigaṇita* and two different works having the common title *Sūryacchāyādi-gaṇita.* Acyuta Piṣāraṭi, too, has written a succinct work on the subject, entitled *Chāyāṣṭakam.*

8. Long-range almanacs

In the matter of preparing annual almanacs, while the general trend in Kerala, as elsewhere, has been to prepare them for one year at a time, efforts had been made to prepare long-range almanacs covering long periods. It has been recorded that Mādhava of Saṅgamagrāma compiled an *Agaṇita-pañcāṅga*[1] which is, probably, the same as referred to in the *Karaṇapaddhati* (IV. 14, 16, 18) and preserved in the Kerala University Oriental Research Institute under the title *Agaṇitagrahacāra.* Śaṅkaran Nampūtiri of Mahiṣamaṅgalam is credited with a 'Register of Muhūrtas'[2] for 1000 years. The *Agaṇita* of Nalleppaḷḷi Subrahmaṇya Śāstri enunciates methods for the facile computation of the planets for a 1000 years.[3]

9. Astronomical rationale

An extremely significant class of astronomical treatises from Kerala refers to disquisitions on the rationale of astronomical formulae and procedures. Short expositions of this nature occur in commentarial literature, especially in the commentaries of Parameśvara, Nīlakaṇṭha Somayāji and Nārāyaṇa, author of *Kriyākramakarī* on the *Līlāvatī.* Single or groups of verses and short tracts pertaining to the exposition of specific points or procedures are often found inscribed on end-leaves of astronomical codices, without indication of source or author. These go mostly unnoticed or ignored by cataloguers of manuscripts. It would, indeed, be highly worthwhile to record, study and analyse these passages with a view to see if some of them contain anything important. In this connection, the discovery of some full-fledged treatises devoted to the exposition of astronomical

1. This reference occurs in an astronomical document preserved in the Oriental Institute, Baroda, *Cf.* K. V. Sarma, 'Direct lines of astronomical tradition in Kerala', *Pt. Charudeva Shastri Felicitation Volume*, Delhi, 1972.

2. See Ulloor, *Kerala Sāhitya Charitram*, Vol. II, (Trivandrum, 1954), p. 272.

3. Ref. to by Ulloor, *op.cit.*, Vol. IV, (Trivandrum, 1957), p. 291.

theories and processes ought to be highly interesting to scholars and historians of mathematics. These texts, which, generally, have the words *yukti* or *nyāya* 'rationale' attached to their titles, explain, interpret and discuss the formulae used and procedures followed in the topics which the texts deal with. Among works of this nature may be mentioned the *Grahaṇa-nyāya-dīpikā* on the computation of eclipses and *Vākyakaraṇa* on the formulation of astronomical mnemonics, both by Parameśvara of Vaṭaśreṇi, the *Yukti-bhāṣā* and *Gaṇita-yukti-bhāṣā*, the former and, possibly the latter too, by Jyeṣṭhadeva, the *Nyāya-ratna* by Putumana Somayāji, the *Gaṇita-yuktayaḥ* by an anonymous 'Bhāradvāja brāhman' and the *Rāśigola-sphuṭānīti* on 'Reduction to the ecliptic' by Acyuta Piṣāraṭi. The *Sundararāja-praśnottara* by Nīlakaṇṭha Somayāji, in which he has explained certain astronomical theories and practices in answer to queries raised by a contemporary astronomer Sundararāja of the Tamil country, also belongs to this category of works. It may also be noted that works solely devoted to the demonstration of procedures call themselves *-kriyā* or *-kriyākrama*, e. g., *Saṅgrahasādhana-'kriyā'* and *Uparāga-'kriyākrama'*.

10. Practical astronomy

Astronomy being a practical science, progress in that discipline is incumbant no less on practical observation than on computational skill. Several works including the *Goladīpikā* I of Parameśvara and the *Bhadradīpa* of Iṭakramañceri Nampūtiri contain sections on the construction and use of the armillary sphere. The commentaries of Parameśvara and Nilakaṇṭha Somayāji carry references to their lifelong astronomical observations. By far the most interesting treatise in this line is the *Grahaparīkṣākrama* of Nīlakaṇṭha Somayāji, in about two hundred verses. There is also a detailed Malayalam commentary on this work. An equally interesting, though possibly, very late, work is *Nāzhikamaṇiyuṭe yukti*, in Malayalam, which is a detailed exposition of the working of the pendulum clock.

11. Revision of astronomical constants

As indicated earlier, the composers of *karaṇa* texts generally started their works with contemporary epochs. Sometimes they also started with corrections to the astronomical constants, and to the sine tables which they incorporated in their works. A work mainly devoted to the enunciation of corrected constants is the *Siddhāntadarpaṇa* of Nīlakaṇṭha Somayāji, wherein he has set out the number of revolutions of the planets, and their higher apses, ascending nodes, maximum

latitudes, velocities etc., as investigated and verified by him. He has also written an elaborate commentary on this work. Some short tracts call themselves *Khaṇḍavum dhruvavum* and merely give the epoch and the corresponding zero-corrections as determined by their respective astronomer-authors. Then again, there exist a large number of manuscripts which form collections of sine tables and mnemonics and are catalogued in libraries under generic titles like *Jyāḥ*, *Jyotiṣa-vākyāni* etc. on account of their not being full-fledged and independent works. These collections are potential sources of additions and novelties to the well-known mnemonics and, so, deserve to be examined from this point of view.

12. Mathematics

The *Līlāvatī* of Bhāskara II, with more than a dozen Kerala commentaries, has remained, as indicated earlier, the most popular textbook on general mathematics. Among indigenous works, some of the astronomical treatises like *Yuktibhāṣā*, *Bhadradīpa* etc. deal with general mathematics in some of their sections. An interesting summary of the general mathematical processes is contained in an anonymous work entitled *Ekaviṁśatipraśnakrama*. Other works solely devoted to the treatment of mathematics are *Kaṇakkatikāram*, with commentary, two works having the same title *Kaṇakkusāram*, one in prose and the other in verse, both with commentaries, *Kaṇakkunūl*, *Kaṇakkucodyam* and *Kaṇakkuśāstram*, all anonymous.

13. Horary astrology

While the classical texts on *Jātakā* used in Kerala were the *Bṛhajjātaka* of Varāhamihira and the *Jātakakarmapaddhati* of Śrīpati, the most popular indigenous text on the subject was the *Jātakapaddhati* of Parameśvara of Vaṭaśreṇi, which has as many as eight commentaries and the *Jātakādeśamārga* of Putumana Somayāji. From among other works, which enjoyed varied popularity, may be mentioned the *Jātakakrama* and *Jātakasāra* of Śaṅkaran Nampūtiri of Mahiṣamaṅgalam, the *Jātakānītimārga* and *Jātakasārasaṅgraha* by Āzhvāñceri Tamprākkal and the anonymous *Jātakodaya*.

14. Auspicious times (Muhūrta)

Practically all the texts popular in Kerala, enunciating the fixation of auspicious times (*muhūrtas*) for the numerous religious and social ceremonies, are of indigenous origin. The *Muhūrtadarśana* of Vidyāmādhava of Nīlamana near Gokarṇa, with six commentaries, and the *Muhūrtaratna* of Govinda Bhaṭṭatiri of Talakkulam, with its

commentary by Parameśvara of Vaṭaśreṇi, are the early texts of this category. But, by far the most popular works on the subject are two *Muhūrtapadavī-s* written by two brothers of the Māttūr family in Cochin, whose names have, hitherto, remained unknown, but can, now, be identified as Puruṣottama and Subrahmaṇya. The popularity of these two *Muhūrtapadavī-s* can be judged from the profusion of manuscripts of these works available and the seven commentaries composed on them.[1]

15. Astrological query (Praśna)

The branch of astrology called *Praśna* has been very popular in Kerala where many a new technique and practice has been evolved. The classical work on the subject which was popular in the land was the *Praśnaṣaṭpañcāśikā* of Pṛthuyaśas, son of Varāhamihira, which claims two good Kerala commentaries. There has, however, been substantial literary production, in consonance with the high popularity of its practice. Here too, several treatises comprehending all aspects of *Praśna* and many others which dealt with special items therein have come to be composed. The most important work of the former category is the *Praśnamārga* by a Nampūtiri of the Panakkāṭṭu family, possibly named Parameśvara. Numerous manuscripts of this work and of the four commentaries on it have been recorded. A good number of later works have been based on it or take it as their chief authority. Other full-fledged works on *Praśna* include three treatises with the identical title *Praśnasāra*, one by Śaṅkara, the second by a Somayāji of Bhūtanāthapura and the third by Mādhava of Īñcakkāzhvā family, two works of the name *Praśnānuṣṭhānapaddhati*, both anonymous, *Praśnāmṛta* of Śrīkumāra, *Praśnāyana* of Puruṣottama with auto-commentary, *Praśnāmīlā*, possibly by Śaṅkaran Nampūtiri of Mahiṣamaṅgalam, with commentary, two works entitled *Praśnarīti*, one by Dāmodaran Nampūtiri of Maṅgalaśśeri and the other by Iṭakkāṭṭu Kūkkaṇiyāḷ and three different works of the name *Praśnalakṣaṇa*, all anonymous. Among works dealing with individual subjects, there are a large number devoted to topics like *Akṣara*, *Aṣṭamaṅgala*, *Ayus*, *Āyudha*, *Pakiṭa*, *Tāmbūla*, *Roga* etc.

16. Natural astrology

Of classical texts on natural astrology, the *Bṛhatsaṁhitā* of

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1. To cite but one instance, the Kerala Oriental Res. Institute and Mss. Library holds in its collections not less than 103 of these manuscripts, as recorded in their catalogues.

Varāhamihira was generally known, besides *Lampaka* by Padmanābha, a later work well known in the whole of South India. Among works on natural astrology produced in Kerala, a mention might be made of *Sāmudrikasāra* of Śaṅkara, with two commentaries, two anonymous *Sāmudrikalakṣaṇa-s* and the *Raṇadīpikā* by Kumāra Gaṇaka. The last-mentioned work which, in eight chapters, deals in detail with the preparation for and conduct of war, is particularly significant. Some works deal with individual topics like *Bhūparīkṣā*, *Rekhāśāstra* etc. and some others like *Naraceṣṭā*, *Pakṣiśāstra* etc. with special types of prognostication.

17. Malayalam versions of Sanskrit texts

It is interesting to note that almost all *Jyotiṣa* works in Sanskrit have one or more commentaries or renderings in Malayalam, produced, obviously, with a view to introduce their study among the non-Sanskrit knowing public. This is a feature found in many other regions of India as well. The Malayalam versions are generally called the *Bhāṣā* of the works concerned. Often the author of the original work himself prepared the *Bhāṣā* and at other times, others. There have also been adaptations and abridgements of Sanskrit works. A very instructive instance of this trend is found in the works of an Āzhvāñcери Tamprākkal who, in a series of works, adapted a number of important Sanskrit texts and also provided the Malayalam renderings of these adaptations. Thus, his *Phalasāra-samuccaya*, in three parts, forms, in its Part I called *Jātakabhāga*, an adaptation of the *Horā* of Varāhamihira and the *Sārāvalī* of *Kalyāṇavarman*, in Part II called *Praśnabhāga*, an adaptation of the *Praśnamārga* of Panakkāṭṭu Nampūtiri, and in part III entitled *Muhūrtabhāga*, of the *Muhūrtadarśana* of Vidyāmādhva. In fact, of the ten works credited to this author, five, *viz.*, *Jyotiśśāstrasaṅgraha*, *Saṅgrahasādhanakriyā*, *Jātakasārasaṅgraha*, *Jātakanītimārga* and *Phalasārasamuccaya*, are adaptations of standard Sanskrit works and the other five, form the *Bhāṣā-s* of these five works.

18. Kerala-Jyotiṣa outside Kerala

That some of the characteristic innovations, extensions and practices evolved in Kerala in the discipline of Jyotiṣa, especially in its astrological aspect, have travelled beyond its borders and become current in certain other parts of India is but natural. It is again natural that, as these theories and practices grew popular in those regions, local treatises came to be composed incorporating the new ideas. Most of these treatises are distinguished by the term 'Kerala' tacked

on to their titles.[1] However, what seems highly significant in this matter is the variety and profusion of the works that have been composed in this manner. About 125 works of this nature have been identified in the different Manuscripts Libraries.[2] Their non-Kerala origin has been determined from one or more of the following indications : (1) Clear mention of alien authorship, (2) the addition of the term 'Kerala' to the title, (3) the popularity of the works in other parts of India, while they are virtually unknown in Kerala, (4) the availability of manuscripts of these works only in non-Kerala scripts and (5) the general absence of manuscripts of the works in Kerala. While the bulk of these works are anonymous, some are apocryphal texts attributed to ancient sages or said to be parts of larger *Tantras* and *Saṁhitās*. Only a few of these are known under the names of their real authors. The disciplines of *Jātaka* and *Praśna* claim the largest number of these works, the former about 30 and the latter about 40.

In horoscopy, some of the works are comprehensive treatises, like for example, *Kerala-rahasya* or *Kerala-jātakānanda* ascribed to Śukrācārya, *Kerala-sūtra* ascribed to Marīci, *Kerala-śāstra-sūtra* or *Jātakālaṅkāra* ascribed to Nikaṣā, and the two anonymous works *Keralīya-jātaka* and *Keralīya-jātaka-saṅgraha*, while the others are devoted to specific aspects of astrology like *bhāva-s*, *daśā-s* and *yoga-s*. An interesting work is *Kerala-horāvyākhyā* by Sarvartupaṇḍita who composed that work at Vijayanagar at the instance of his patron Gopāla.

Most of the texts on *Praśna* are anonymous. Among those whose authors, real or apocryphal, have been indicated are : *Kerala-praśna-grantha* and *Kerala-granthodāharaṇa* both by Mūladeva, *Kerala-śāstra*, *Kerala-praśna* and *Pāśaka-keralī*, all by Garga, *Keralī* by Rāvaṇa, and *Keralīya-praśnaratna* by Nandarāma Paṇḍita. Of peculiar subjects dealt with are prognastication (1) on the basis of letters in the *Akṣaracintāmaṇi* section of *Keralamata* ascribed to Śiva, *Keralapraśna* or *Keralīya-jñāna* and *Akṣarakevalīpraśna*, both anonymous ; (2) on the basis of the throw of the dice in *Kerala-pāśāvalī* of Garga and the two anonymous works *Keralī-praśnavicāra* and *Keralīya-śakunāvalī* ; and

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1. This phenomenon is found, in varying degrees, also in the case of certain other disciplines like Tantra, Śrauta, Dharma and Mantraśāstra.

2. For a classified and documented list of the manuscripts of these non-Kerala works, see Appendix, below.

(3) on the basis of arecanuts in *Keralapraśna* (anonymous, Mithila III. 180). Of works on natural astrology, a mention might be made of *Keralayātrā* on setting out on a journey, and *Keralī* on the throbbing of the limbs and on dreams, both anonymous, and *Keralī-śakuna*, on omens, the last being attributed to Vyāsa.

The desideratum. The non-Kerala works on Kerala Jyotisa, mentioned above, demonstrate how the specialities of a discipline as evolved in one region of India have been transmitted to the other regions of the country and how they have been accepted, preserved and propagated in those parts under the label of their original place of origin. It is well to remember here that it is but natural that during their transmission and propagation through the centuries, some of the original ideas might have undergone some modifications. It is also possible that some new or local ideas have come to be incorporated in these works and paraded as Keralite views. It would be extremely instructive to investigate this subject fully. Comparative studies between the non-Keralite works and allied Keralite works could show how far the former represent the original views. The textual or other sources from Kerala, if any, of the individual non-Keralite works have to be identified. It would also be interesting to examine why these works are almost always unknown in Kerala, the land to which the ideas expressed therein are supposed to belong.

CHAPTER VI

KERALA ASTRONOMERS

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1. Introductory

The approach of the Kerala astronomers to the study of that discipline and the broad trends of their writings, as set out in the previous chapters, should form the natural background for an apprisal of the literature produced in the land on astronomy and, for the sake of fullness, also on the allied discipline of astrology. Such an apprisal is attempted in the two chapters that follow. In the present chapter, the major writers are taken note of and in the next chapter is presented a fully documented Inventory of the available literature on these disciplines. It may be noted that the said Inventory carries references to the manuscripts, editions and studies relating to as many as about 950 works on astronomy, astrology and mathematics and details of about 110 authors and authorities.

2. Earlier documentation

Several efforts have been made before to take stock of Hindu astronomical and allied literature, including that of Kerala, though these attempts have hardly succeeded in giving any adequate idea of the extent of the literature produced in Kerala. 'A brief bibliography of Hindu mathematics' by G.R. Kaye[1] records but a single work from Kerala, being the commentary of Paramadiśvara (sic.) on the *Āryabhaṭīya*. The *Gaṇakataraṅgiṇī or Lives of Hindu astronomers* by Sudhakara Dvivedi mentions just four Kerala authors and two works.[2] 'A consolidated list of Hindu mathematical works' by K. Balagangadharan[3] includes just 18 Kerala authors and 42 works. K.K. Raja's well-documented paper on 'Astronomy and mathematics in Kerala : An account of the literature',[4]

1. *Jl. and Proc. of the Asiatic Soc. of Bengal*, (NS) 7 (1911) 679-86.

2. Rev. edn. by Padmakara Dvivedi, Banares, 1933. The Keralite authorities referred to herein are Parameśvara, Kṛṣṇācārya, Govinda and Vidyāmādhava, among authors, and *Bhaṭadīpikā* and *Daśādhyāyī*, among works.

3. *Mathematics Student*, 15 (1947) 55-70.

4. *Adyar Library Bulletin*, 27 (1963) 118-67.

takes into its purview only some of the more prominent authors in these two disciplines, numbering about 20, and their works, numbering about 80. S.N. Sen's *Bibliography of Sanskrit works on astronomy and mathematics*,[1] carries the documentation of just 13 Kerala authors and 47 works. The major histories of Kerala literature, *viz.*, *Kerala Sahitya Charitram* (in 5 vols.) by Ulloor S. Parameswara Aiyar,[2] *Keraliya Samskrita Sahitya Charitram*, (in 6 vols.)[3] and *Kerala Sahitya Charitram : Charcchayum Pūraṇavum*, (in 2 vols.),[4] both by Vaṭakkumkūr Rajaraja Varma, *Malayala Bhasha Charitram* by P. Govinda Pillai,[5] and *Kerala Bhasha Sahitya Charitram* (in 7 vols.), by R. Narayana Panikkar,[6] especially the first three, notice a much larger quantom of the literature, though they, too, fail to do adequate justice to the subject. In fact, more than half of the literature on Joytiṣa produced in Kerala does not find a mention in these volumes. Moreover, the accounts given in these histories are not documented and are, mostly, distributed in their different volumes. Neither do these histories, except that of Ulloor, carry any index to help the reader in locating a work or an author dealt with therein. Under the circumstances as stated above, the wealth of material presented, in a chronological manner, in the following pages may be expected to provide a far more comprehensive account of the literary output of Kerala in the discipline of Jyotiṣa. It has been thought not necessary to repeat here the details which are available in the earlier accounts, but it was felt essential to set out all new information not noticed in therein. Therefore, in the following pages, the stress will be on new information, identifications and correlations, although, for the sake of completeness and continuity, a brief mention will be made also about currently known authors and works, for further details about which the earlier writings referred to in the footnotes might be consulted with advantage. For the documentation of the manuscripts of the works and for extracts therefrom, the annotated Inventory in the next chapter might be referred to.

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1. Part I : *Manuscripts, Texts, Translations and Studies*, National Institute of Sciences of India, New Delhi-1, 1966.

2. Pub., University of Kerala, Trivandrum, 1953-57.

3. Pub., Vol. I, Kamalalaya Book Depot, Trivandrum, M E. 1113 (A. D. 1938), Vols. II-VI, Mangalodyam, Trichur, M. E. 1122-40 (A.D. 1947-65).

4. Pub., Mangalodayam, Trichur, 1967-69.

5. Reprint, National Book Stall, Kottayam, 1955.

6. Pub., Vidyavilasini Book Depot, Trivandrum, n.d.-1951.

3. Vararuci I (4th cent. A.D.)

Vararuci is the father figure in the astronomical tradition of Kerala. He is supposed to have lived in the first half of the 4th century, this date having been arrived at on the basis of the dates of birth and death of his eldest son Meḷattoḷ Agnihotri, which are given, according to tradition, in the Kali chronograms *yajñasthānam surakṣyam* (12,70,701) and *purudhīḥ samāśryaḥ* (12,57,921) which fall, respectively, in A.D. 343 and 378. The manuscript tradition of the land ascribes to Vararuci the authorship of the 248 *Candra-vākyas* ('moon-sentences'), popularly called *Vararuci-vākyas*, beginning with *gīr naḥ śreyaḥ*, and also the promulgation of the *kaṭapayādi* notation of depicting numbers which has been used in the composition of the said *Vākyas*.[1]

4. Vararuci II

In horary astrology, the work *Kerala-dvādaśabhāvavākyāni*, in 12 chapters, is ascribed to Vararuci; the manuscripts of the work carry expressive colophons such as *iti Keralīya-Vararuci-vākye* and *Kerala Vararuci-prokta*. Two anonymous works, both entitled *Kerala-dvādaśabhāva-phalam*, one in verse and the other in prose, are allied to Kerala-Vararuci's work mentioned above. Another work of Vararuci is the *Vārarucika*, an extenstive treatise on general astrology in 12 chapters. Still another work called *Vararuci-kerala* called also *Jātakarahasya* and *Kerala-rahasya* on horoscopy is, also, attributed to him. The Vararuci, who is the author of the above works on astrology might be identical, but it is not possible to assert that he is the same as the author of the *Candra-vākyas*.

5. Haridatta (*c.* 650-700)

Haridatta, as noted earlier, has the distinction of promulgating,

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1. On Vararuci, see Raja, pp. 120-22; Ul. vol. I. pp. 77-81, 165; Va. vol. I. pp. 90-95. There is another astronomer named Vararuci, the author of the well-known *Vākyakaraṇa* (ed. T. S. K. Sastri and K. V. Sarma, Madras, 1962), which is the source-book of the *Vākya-pañcāṅga*, popular in South India, especially the Tamil region. But this Vararuci, whether the name is real or apocryphal, belonged to the Tamil region, as is clear from the introductory verses of that work. It has also been shown that this is a 13th century work, having been composed between 1282 and 1306, as can be inferred from the *śodhya-dina* ('deductive day') made use of in that work as a 'zero-day' for computations (*vide op. cit.*, Intro., p. ix). For some Keralite legends on Vararuci, see Koṭṭārathil Śaṅkuṇṇi, 'Paṟayipeṟṟu pantiru kulam' (Mal.), ('The twelve families born of a woman of the Paṟaya caste'), *Aitihyamāla*, (6th edn., Trichur, 1961), pp. 60-90,

in 683, at Tirunāvāy in Kerala, a new system of astronomical computation called *Parahita*, which presented distinct advantages over the prevailing Āryabhaṭan system.[1] One of the important corrections which he introduced was called the *Śakābda-saṁskāra* or *Bhaṭa-saṁskāra*.[2] His *Grahacāranibandhana*, of which and of whose summary critical editions are available,[3] is the working manual of the system. His comprehensive treatise on astronomy entitled *Mahāmārganibandhana*, referred to in the *Grahacāranibandhana* (III. 44), is yet to be recovered. The well-known verse *vāgbhāvonāt* etc., enunciating his *Śakābda-saṁskāra*, which does not occur in the shorter manual, must be from this treatise;[4] so also Nīlakaṇṭha Somayāji's quotation in his *Grahaṇādi-grantha* (ms., p. 59) which reads: *atra Haridattaś cāpy āha—'caturdaśabhāgāntaś calanty eva grahās tataḥ'*. The *Parahita* system of computation, which grew highly popular, has played a leading role in the propagation and practice of astronomy in Kerala.[5]

6. Govindasvāmin (*c.* 800-850)

In Govindasvāmin, teacher of Śaṅkaranārāyaṇa (see below) who was the court astronomer of King Ravi Varma Kerala, we have one of the ablest exponents of Bhāskara I and of the Āryabhaṭan system. His elaborate *Bhāṣya* on the *Mahābhāskarīya*[6] contains new ideas and mathematical elaborations which remain to be fully recognised and expounded in terms of modern mathematics.[7] An original work of his on astronomy and mathematics, which is quoted under the title *Govindakṛti* by later writers like Śaṅkaranārāyaṇa, Nīlakaṇṭha

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1. See above, pp. 7-8.
2. On this see above, p. 9.
3. Cr. ed. with Intro., K.V. Sarma, K.S.R. Institute, Madras, 1954.
4. For this verse and its exposition, see above, p. 9.
5. On Haridatta, see: K.V. Sarma, Intro. to his edn. of *Grahacāranibandhana*, *op. cit.*, and 'The original text of Parahita-gaṇita', (Mal), *Mathrubhumi Weekly* (Kozhikode), 10.10.1954; Raja, 1?3-26.
6. Cr, ed, T. S. Kuppanna Sastri, Madras, 1957.
7. For an exposition of some of these, see R. C. Gupta, 'Second order of interpolation in Indian mathematics', *Indian Jl. of Hist. of Sc.*, 4 (1969) 86-98; 'Fractional parts of Āryabhaṭa's sines and certain rules found in Govindasvāmin's *Bhāṣya* on the *Mahābhāskarīya*', *ibid.*, 6 (1971) 51-59.

Somayāji and Nārāyaṇa,[1] is yet to be recovered. So also is his work on astrology which is referred to by Nīlakaṇṭha as *Govindapaddhati*.[2] However, manuscripts of his short commentary called *Prakaṭārtha* or *Sampradāyapradīpikā* on *Parāśarahorā* are known but it is yet to be issued in print.[3]

7. Śaṅkaranārāyaṇa (*c.* 825-900)

Ravi Varma, the 9th century ruler of the Cera dynasty of Kerala had as his chief court astronomer Śaṅkaranārāyaṇa disciple of Govindasvāmin. Śaṅkaranārāyaṇa was a native of Kollapuri on the Arabian coast. The only known work of his is a commentary on the *Laghubhāskarīya* which he wrote in A. D. 869.[4] Besides being highly elucidatory with regard to the subject treated therein, the work throws light on the keen interest evinced by the royalty in the promotion of the study of astronomy, the presence of an astronomical observatory at the capital city Mahodayapuram (modern Koṭungalloor near Cochin), the construction of buildings with due reference to mathematical principles, arrangements made in the city for announcing the times of the day—which all point to the conditions that greatly favoured the flowering of astronomical studies in that part of India.[5]

8. Udayadivākara (11th cent.)

Udayadivākara, surnamed Jyotiṣikabhaṭṭa, author of the elaborate commentary called *Sundarī* on the *Laghubhāskarīya*, which takes as its epoch 1073,[6] probably hailed from Kerala. In the *Sundarī* he quotes as many as twenty verses from an unnamed work of a

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1. For instance, see *Śaṅkaranārāyaṇa* in his com. on *Laghubhāskarīya*, *TSS*, No. 162, pp. 19, 55, 95 ; Nīlakaṇṭha, *Grahaṇādigrantha*, ms., pp. 35, 42, 44.

2 See his *Grahaṇādigrantha*, ms., p. 44.

3. On Govindasvāmin, see : T.S.K. Sastri, Intro , to his edn. of *Mahābhāskarīya*, *op. cit.*, pp. xlvi-l ; Raja, 127-28 ; Ul. II.96-97. The identification of our author with the 13th cent. Govinda Bhaṭṭatiri, au. of *Muhūrtaratna*, made by Ulloor (I.169, II 96, 97) is not correct. Again. Ulloor (I.169) refers to a com. on the *Āryabhaṭīya* by our author, but no such com. is known.

4. Ed. *Trivandrum Skt. Ser.*, (*TSS*), No. 162, (Trivandrum, 1949).

5. On Śaṅkaranārāyaṇa, see, Intro. to the above edn., pp. x-xv ; Raja, 128-29 ; Ul. I. 165-67 ; Va. IV, 221-23. Va.'s statement (IV. 222) that *Bṛhatkarmanibandhana* is a work of this author is not correct. *Bṛhatkarmanibandhana* is another name for the *Mahābhāskarīya* of Bhāskara I.

6. Śaka 995, as given in his com. on *Laghu.*, II. 29.

mathematician Jayadeva and comments on them.[1] His comments on Jayadeva are quoted also in the *Līlāvatīvyākhyā* (*Kriyākramakarī*) by Nārāyaṇa (Madras Ms. R. 2754, pp. 182, 183-84, 185). Possibly Udayadivākara has commented on Jayadeva's work in full.

9. Acyuta I

An extensive work on analytic astrology, called severally as *Devakerala*,[2] *Keralajyotiṣa*, *Candranāḍī* and *Candrakalānāḍī*, introduces itself as to have been compiled from the teachings of Acyuta, a brahman from Kerala. Acyuta propitiated, by penance, Bṛhaspati, who taught him the *Jātakaskandha*. In a similar manner, Acyuta propitiated Śukra and Parameśvara also and got from them their teachings as well, which he propagated.[3] Neither the date of this Acyuta nor any personal details about him is known. The *Devakerala* which represents his teachings is, obviously, a compilation by his disciples, among whom Veṅkaṭeśa of the Kāśyapagotra is specifically mentioned as the redactor of the *Uttarabhāga* of the work.[4]

10. Keralācārya (? 12th cent.)

According to current tradition, Keralācārya hailed from Trichur in Central Kerala and belonged to the Kāśyapagotra. It is also said that he was a minister of King Rāma Varmā who ruled in Kerala from 1108-32. He wrote on Jyotiṣa, Āyurveda and Tantra. His works on

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1. For a study on these verses, see K. S. Shukla, 'Ācārya Jayadeva, the mathematician', *Gaṇita*, (Bharat Ganita Parishad, Lucknow), 5 (1954) 1-20.

2. Ed. by T. S. Ranganatha Josyar, in 3 parts, *Madras Gov. Or. Ser.*, Madras, 1952-56.

3. *Cf.*: *Kerale viṣaye kaścid Acyuto nāma bhūsuraḥ /*
Bṛhaspatim samuddiśya sa cakre tapa uttamam //

prasādasumukhas tasmai prāha devapurohitaḥ /
tapasā tava tuṣṭo 'smi vatsa kim te karomy aham // ...

yan mayānukṛtam pūrvam Jātakaskandham uttamam /
dvisahasreṇa saṅkṣipya tvatkṛte procyate 'dhunā // ...

Acyuto 'pi punaḥ prītas tapasārādhya Bhārgavam /
tasmāt sahasrasaṅkhyākam prāptavān Bhārgavam matam // ...

śiṣyān adhyāpayāmāsa śāstram tad Devakeralam / ...

4. *Cf.*: *abhivandya mataṅgākhyam śrīmad-veṅkaṭanāyakam /*
Kāśyapo Veṅkaṭeśo 'ham phalam vakṣyāmi bhūbhujām //

(Intro. verse)

Jyotiṣa included *Kerala-saṁhitā*, *Kerala-nāḍīgrantha*, *Keralīyapraśna-mārga* and *Keralapraśnasāra*. However, as observed earlier, these works must, obviously, be non-Keralite treatises based on Keralite teachings attributed to Keralācārya.[1]

11. Vyāghrapāda

Aṅkaṇaśāstra,[2] called also *Grahasamaya* and *Navagrahasamaya*, has, obviously, been composed by a devotee of god Śiva enshrined at Vaikkom (Skt. Puṇḍarīkapura) in Central Kerala and attributed to sage Vyāghrapāda, the establisher of that place. It is an interesting treatise in analytical astrology, intended as a supplement and corrector to general horoscopic astrology and contains 389 verses, divided into four chapters. Herein, each of the twelve *lagna-rāśis* (ascending zodiacal segments) are divided into nine *aṅkaṇa-s* ('court-yards'), each *aṅkaṇa* being presided over by a planet having individual characteristics. Minute prognostications are made on the basis of the effects of these planets.[3]

12. Kṛṣṇa (c. 1200)

Kṛṣṇa, called also Kṛṣṇācārya, is the author of *Cintājñāna*, a comprehensive work on astrology in thirtytwo chapters. No personal details about him are known but his being quoted frequently as an authority by later writers, the earliest of them being Govinda Bhaṭṭatiri of Talakkuḷam (1237-95), is a pointer to his popularity and his date, which might be taken to be about 1200 or before. He may be identical with Kṛṣṇa, the author of a commentary on the *Horā* of Varahamihira, of which a manuscript has come to light. Kṛṣṇa's *Cintājñāna* has a popular commentary called *Caturasundarī* by Viṣṇu.[4]

13. Kṛṣṇa-śiṣya (*c.* 1200)

Kṛṣṇa had in one of his disciples, who does not disclose his name or give any other personal details, an ardent admirer and propagator of his teachings. This disciple has composed two works, one a metrical commentary on the *Horā* and the other a short treatise in verse on astrological query, entitled *Praśnaphalaprāptikāla-nirṇaya*. In both these works, he mentions his teacher in high terms

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1. See above, pp. 38-40.
2. Ed. by K. Raghavan Pillai, *TSS*, No. 222, Trivandrum, 1968.
3. On this work, see Intro. to the edn. cited above and Ul. Sup. I. 221-22.
4. On Kṛṣṇa, see Ul. I. 169-70.

and, in the latter, goes to the extent of saying that the minds of those who have imbibed the teachings of Kṛṣṇācārya would remain unassailed so far as prognastication is concerned.[1]

14. Sūryadeva Yajvan (1191-*c.* 1250)

Sūryadeva Yajvan of the Nidhruva gotra and nephew of another Sūryadeva was a versatile commentator and recognised authority. He gives his date of birth as '*viśveśa*' (1113) *śaka* in the colophon to his commentary on the *Tripraśnādhyāya* of the *Laghumānasa* of Muñjāla. His elaborate commentaries on the *Laghumānasa* and the *Āryabhaṭīya* are available, but that on the *Mahābhāskarīya-bhāṣya* of Govindasvāmin is known only from his reference to it. On astrology, he commented on the *Mahāyātrā* of Varāhamihira, and the *Jātaka-karmapaddhati* of Śrīpati, both of which are popular.[2]

15. Vidyāmādhava

Vidyāmādhava, whose commentary on the *Kirātārjunīya*, is perhaps, the best exposition of that *mahākāvya*, was equally at home in Jyotiṣa. His *Muhūrtadarśana*, called also *Muhūrtamādhavīya* and *Vidyāmādhavīya*,[3] is an extensive work in 15 chapters, discussing and prescribing auspicious times for all types of social and religious functions. He was a member of the Tuḷu brahman family of Nīlamana, his village being Guṇavatī (Guṇavanta), near Gokarṇa, on the Arabian coast. He was the son of Nārāyaṇa, an eminent scholar attached to the court of King Mallappa. The *Muhūrtadaraśna* has been extremely popular in Kerala and has six Keralite commentaries on it, two in Sanskrit and the others in Malayalam.[4]

16. Viṣṇu of Nīlamana

Viṣṇu was the son of Vidyāmādhava and had the distinction of commenting upon his father's *Muhūrtadarśana*. This commentary,

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1. See the verses extracted in the Inventory, below, under the respective works.

2. On Sūryadeva, see Raja, 131-32, Sen, p. 124 ; Ul. II. 97-98 ; Ul. Sup. I. 219 ; Va. I. 390-92.

3. Ed. by Shama Sastry, *Vidyāmādhavīyam* with Viṣṇuśarma's *Muhūrtadīpaka*, *Bibl. Sanskrita*, Nos. 63, 67, 70, Or. Res. Inst., Mysore, 1923, 1925, 1926.

4. On Vidyāmādhava, see, Ul. II. 95 ; Ul. Sup. I.540 ; Va. I. 441-44.

called *Dīpikā*,[1] is highly elucidatory and informative and has been as much popular in the land as its text.[2]

17. **Govinda Bhaṭṭatiri of Talakkuḷam** (1237-95)

Govinda Bhaṭṭatiri of Talakkuḷattūr family belonged to the village of Ālattūr in S. Malabar and is renowned as the progenitor of the famous Pāzhūr Kaṇiyār family of astrologers A line of astronomical tradition which he started continued for more than 700 years.[3] The dates of his birth and death are given by tradition by the Kali chronograms *rakṣed govindam arkaḥ* (15,84,362) and *kālindīpriyatuṣṭaḥ* (16,12,891), which fall, respectively, in A. D. 1237 and 1295. His elaborate commentary *Daśādhyāyī* on the *Horā*, called so on account of its commenting only chs. I to X of the work, deals, in substance, with the entire *Horā*.[4] His *Muhūrtaratna* has been very popular. He is said to have written also a *Muhūrtapadavī*, which formed the basis for several later works of that name (Ul. II. 110).[5]

18. **Tāmaranallūr** (14th cent.)

A member of the Tāmaranallūr family has produced an authoritative work entitled *Muhūrtavidhi*, called also *Muhūrtam Bhāṣā*. The work is popularly known as *Tāmaranallūr Bhāṣā*, after its author. It deals with the fixation of auspicious times for functions and is composed

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1. Ed. with text, *op. cit.*

2. The colophon to the commentary on ch. XI reads :

Muhūrtadarśanādarśavyākhyāne Viṣṇunā kṛte /
vyācaṣṭaikādaśādhyāyam Vidyāmādhavanadanaḥ //

On the basis of this Ulloor (II. 95) distinguishes between Viṣṇu and Vidyāmādhava's scn and states that while the disciple Viṣṇu is the main commentator, ch. XI was commented by Vidyāmādhava's son. But, for the identity of the two, see colophon to the com. on ch. V :

ittham Vidyāmādhavīye Muhūrtādarśe 'Vidyāmādhavasyātmajena' /
vyākhyāto 'bhūd gumphite 'Viṣṇunāmnā' vīryāvīryam darśanam pañcamo 'yam //

3. See above, pp. 5-6.

4. Pub. under the title *Daśādhyāyī*, Venkatesvara Press, Bombay, Saṁ. 1969 (A.D. 1912) ; Vidyakalpataru Press, Palghat, (1905), (in grantha script).

5. On Govinda Bhaṭṭatiri, see : Raja, 132-33 ; Ul. I. 167-69, II. 110 ; Va. I. 353-59, II 499-500. For the legends about him see, Koṭṭārathil Śaṅkuṇṇi, 'Talakkuḷattūr Bhaṭṭatiriyum Pāzhūr paṭippurayum' (Mal.), *Aitihyamālā*, I, (6th edn., Trichur, 1961), 99-108.

in early *bhāṣā-miśra* (Skt.-Mal.) verses. The author, who does not reveal his personal name, makes mention of his patron Ceyyūr (?Cellūr) Nārāyaṇan Nampūtiri and might have hailed from Periñcellūr in Malabar.[1]

19. **Nityaprakāśa Yati** (14th-15th cent.)

Nityaprakāśa Yati or °Bhaṭṭāraka, about whom the only personal information known is the name of his preceptor, *viz.*, Ānandaprakāśa, has commented on the *Horā*, both in Sanskrit and in Malayalam. Both the commentaries are elaborate and are called *Prakāśikā*. The Sanskrit commentary is called also *Viṣamākṣaravivṛti*. The language of the Malayalam commentary, which is characterised by mediaeval traits,[2] would suggest for it a date in the 14th-15th century.

20. **Kumāra Gaṇaka** (*c.* 14th-15th cent.)

Kumāra Gaṇaka is the author of *Raṇadīpikā*,[3] which he composed at the instance of Deva Śarmā, younger brother of Govinda, a Kerala prince, probably of the principality of Cempakaśśeri (modern Ampalappuzha). The work deals with politics, royal conduct and war, on the background of natural and horary astrology. It is divided into eight chapters, called *viveka-s*, devoted, respectively, to *Naya*, *Yātrā*, *Jayājaya*, *Kāla*, *Śūlacakrādi*, *Pañcasvara*, *Mṛgavīrya* and *Bhūbala*. The author writes very readable poetry and reveals a liberal and progressive bent of mind.[4]

21. **Rudra I** (*c.* 1325-1400)

Parameśvara Vaṭaśreṇi (1360-1455), of *Dṛggaṇita* fame, has mentioned in several of his works, Rudra, the eminent astronomical authority at whose feet he learnt the discipline. This Rudra's has, however, not been identified as the author of any work.[5]

1. On Tāmaranallūr, see Ul. I. 460-1 ; Ul. Sup. I 146 ; Va. III 396. Two manuscripts of the work, Ker. 4147-A and PM 4113-B, call themselves *Muhūrtapadavī Bhāṣā*. It remains to be seen whether it is related to the *Muhūrtapadavī* of Govinda Bhaṭṭatiri of Talakkuḷam.

2. *E. g.*, see the lines : *yāvad gataḥ śītakaro* etc. (*Horā* 24. 6) : *enpatu praśnam peṇṇina pozhutu praśnarāśikku ettanaȳām rāśiyile candran ninṟān enṟu inta candran ninṟa rāśi piṭittu akkaṇakkeṇṇi avvirāśiyile candṟan nilkaṟpiṟantān enṟu colluka* / (*Des. Cata. of Skt. Mss. in H H. the Maharaja's Palace Library, Trivandrum*, Ms. No. 995, (vol. IV, p. 1315).

3. Ed. *TSS*, No. 95, Trivandrum, 1923.

4. On Kumāra Gaṇaka, see Ul. II. 112-13 ; Va. II. 725-29

5. On Rudra, see Raja, 138.

22. Mādhava of Saṅgamagrāma (*c.* 1340-1425) : Mādhava I

Mādhava, referred to by later astronomers as *Golavid* ('Master of spherics'), was an astute mathematician who belonged to Saṅgamagrāma, identified with Irinjālakkuḍa, near Cochin. According to an old astronomical document, he belonged to the sub-caste of Kerala brāhmans called Emprān-s and the name of his house was Ilaññippaḷḷi.[1] In his *Veṇvāroha*,[2] he evolved a facile procedure to read out the true positions of the Moon every 36 minutes.[3] He uses, in this work, a date in A. D. 1400 as the epoch, which gives a clue to his date. Among his known works are *Lagnaprakaraṇa* and a table of moon-mnemonics correct to the seconds. His *Mahājyānayanaprakāra* and *Madhyamānayanaprakāra*, for which short commentaries are available, contain novel theorems and computational methods evolved by him and used by later writers.

An important work of Mādhava, which may be identified here, is his *Agaṇita*. The astronomical document mentioned above states that Mādhava is the author also of an *Agaṇitapañcāṅga*. An anonymous *Agaṇitagrahacāra* which has been quoted by *Karaṇapaddhati* (IV. 14, 16, 18) and is available in manuscript form mentions the *śodhyābdas* ('deductive years') for the computation of Mars, Mercury, Jupiter, Venus, Saturn and Moon's Higher Apsis as Śaka 1320, 1318, 1340, 1158, 1201 and 1276, corresponding to A.D. 1398, 1396, 1418, 1236, 1379 and 1354.[4] Since the principle underlying the *sodhyābdas* is to fix them in such a way that the largest possible number of

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1. *Cf.* the words: *Mādhavan Veṇvārohādīnām karttā. ... Mādhavan Ilaññippaḷḷi Emprān*, in a Kerala manuscript, No. 9386, preserved in the Oriental Institute, Baroda, and ed. by K. V. Sarma in the paper 'Some direct lines of astronomical tradition in Kerala', Pt. Charudeva Shastri Felicitation Vol., Delhi, 1972.

2. Cr. ed by K. V. Sarma, with the commentary of Acyuta Piṣaraṭi, Sanskrit College, Trippunithura, 1956.

3. For a note on other works of this genre, see above, pp. 32-33.

4. *Cf.* Ms. T. 280, *Cata. of the Skt. Mss. in the Curator's Office, Trivandrum*, Vol. IV, p. 1305 :

śakābdāt 'naraloko'nād rāghavair dhītsunā kujaḥ /
'divyaloko'-nanīlāgrais tattvajñair bhājite budhaḥ //

'navaloko'-nasārāṅgair gajair āpte gurur bhavet /
'hemapuṇyo'-naśākābdāt sāravair govarair bhṛguḥ //

'yajñaloko'-nanītamśair dharmair āpte śanir bhavet /
'tīrthapriyo'na-śākābdād gandhajñair bhājite tamaḥ //

years will be cut off from the number of the current year, thereby providing maximum ease in calculation, the *śodhyābdas* selected would be as near as possible to the date of the composition of a work, which date would, naturally, be just ahead of the largest *śodhya*. In the case of the *Agaṇitagrahacāra* in question, the *śodhyābdas*, with A. D. 1418 as the latest among them, agrees, surprisingly, with the date of Mādhava. This goes to confirm that in the present *Agaṇitagrahacāra* we have a hitherto unidentified work of Mādhava, *viz.* his *Agaṇitapancāṅga* which is mentioned in the said astronomical document. Again, it seems quite possible that Mādhava had composed a comprehensive treatise on astronomy and mathematics, which yet remains to be identified and which may be supposed to contain the numerous single and groups of verses enunciating computational procedures, theorems and formulae which are quoted as Mādhava's by later writers. Possibly, Mādhava wrote also a work named *Golavāda*[1] which gained for him the appellation *Golavid* by later scholars.[2]

23. Parameśvara of Vaṭaśreṇi (*c.* 1360-1455) : **Parameśvara I**

Parameśvara, one of the foremost astronomers of Kerala who revised the *Parahita* system of computation through his *Dṛggaṇita* in 1430, has made significant contributions to Hindu mathematics and astronomy. He was a Ṛgvedin of the Āśvalāyana-sūtra and the Bhṛgu-gotra. He hailed from the village of Aśvatthagrāma (Mal. Ālattūr) and his house Vaṭaśreṇi (Mal. Vaṭaśśeri) was situated on the confluence of river Nīḷā (Mal. Bhāratappuzha) with the Arabian Sea, where, on the sandy expanse, he carried on investigations for fiftyfive years. He also observed a large number of eclipses, of which he has recorded the details in his *Siddhāntadīpikā*.[3] His grandfather was a disciple of

1. A matter of melencholy interest might de mentioned here, at least for record. The presence of a work entitled *Golavāda* written in continuation of Mādhava's *Veṇvāroha* in a manuscript preserved in the Eḷankunnappuzha Naṭakkal Kovilakam, near Ernakulam, raised in the present writer the hope that that could, possibly, be a thitherto unknown work of Mādhava. When, however, he proceeded to the said Kovilakam and, with a good deal of persuasion, caused the wooden box containing the family collection of manuscripts to be opened, he found that all the manuscripts in that box, including that of *Golavāda*, had been completely eaten away by white ants. For further details, see his note on the subject in the *Mathrubhumi W*, (Kozhikode), 17.6.1956, p. 4.

2. On Mādhava, see: K. V. Sarma, Intro. to the edn. of *Veṇvāroha*, *op. cit.*: 'Saṅgamagrāma Mādhava', (Mal.), *Mathrubhumi W*, 4. 11. 1956, pp. 17-18, 59; Raja. 133-36; UI. II. 91-100; Va. I. 387-88, III. 388-90.

3. On Parameśvara's extensive astronomical observations, see above, pp. 2-4.

Govinda Bhaṭṭatiri of Talakkuḷam and he himself was a pupil of Rudra I, Nārāyaṇa son of Parameśvara and Mādhava of Saṅgamagrāma.

Parameśvara was a prolific writer, author of about 30 works, including original treatises and commentaries, both on astronomy and astrology. Among his original writings on astronomy might be mentioned the *Dṛggaṇita* (1430),[1] three works on spherics, being the *Goladīpikās* I-III (1443),[2] three works on improved computation and rationale of eclipses, *viz.*, *Grahaṇāṣṭaka*,[3] *Grahaṇamaṇḍana*[4] and *Grahaṇanyāyadīpikā*,[5] a text on the computation of the Moon-shadow, entitled *Candracchāyāgaṇita* and a rationale on the computation of mnemonic tables, *Vākyakaraṇa*.[6] He has commented on the *Āryabhaṭīya*,[7] *Mahābhāskarīya*,[8] *Mahābhāskarīya-bhāṣya*,[9] *Laghubhāskarīya*,[10] *Sūryasiddhānta*, *Laghumānasa*,[11] *Līlāvatī*, *Goladīpikā* I[12] and *Vyatīpātāṣṭaka*. Some of his commentaries, like, for instance, those on the *Āryabhaṭīya* and *Mahābhāskarīya-bhāṣya*, are extremely valuable for the historian of Hindu astronomy, since they contain the enunciation of some of his new findings, theories and interpretations. Two of his works on astronomy, *viz.*, *Vākyadīpikā* and *Bhādīpikā*, are yet to be recovered. His writings on astrology include *Ācārasaṅgraha* in two versions, one of them ending with *Vivāhānukūlyam*, *Jātakapaddhati*, and *Ṣaḍvargaphalam* and commentaries on the *Jātakakarmapaddhati* of

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1. Cr. ed., K.V. Sarma, V.V.R.I., Hoshiarpur, 1963.

2. I: Cr. ed., K.V. Sarma, Adyar Library, Madras, 1957; II; Ed. T. Ganapati Sastri, TSS, No. 49, Trivandrum, 1916. The traditional date of composition of one the *Goladīpikās* (which one it is not possible to say) is given by the chronogram *dīyatām* (M.E. 618) equivalent to A.D. 1443, is given by Achyutattu Vasudevan Moossatu in his collection of chronograms entitled *Maṛakkātta nāḷukaḷ* ('Unforgettable days'), Kunnamkulam, M.E. 1130 (A.D. 1955).

3. Cr. ed., K.V. Sarma, K.S.R. Inst., Madras, 1959.

4. Cr. ed., K.V. Sarma, V.V R.I., Hoshiarpur, 1965.

5. Cr. ed., K.V. Sarma, V.V.R.I., Hoshiarpur, 1966.

6. This *Vākyakaraṇa*, in about 75 verses, is different from the *Vākyakaraṇa* attributed to Vararuci III.

7. Ed., H. Kern, Leiden, 1874; Udaya Narain Singh, Etawah, 1906.

8. Pub., *Ānandasrama Skt. Ser.*, No. 126, Poona, 1945.

9. Cr. ed., T.S. Kuppanna Sastri, Gov. Or Mss. Lib., Madras, 1957.

10. Pub., *Anandasrama Skt. Ser.*, No. 128, Poona, 1946.

11. Pub., *Anandasrama Skt. Ser.*, No. 123, Poona, 1944.

12. Cr. ed., K.V. Sarma, Adyar Library, Madras, 1957.

Śrīpati, *Praśnaṣaṭpañcāśikā* of Pṛthuyaśas, an anonymous *Muhūrtāṣṭaka* and the *Muhūrtaratna* of Govinda Bhaṭṭatiri.[1]

24. Dāmodara of Vaṭaśreṇi (*c.* 1410-1510) : **Dāmodara I**

Of Dāmodara, son of Parameśvara of Vaṭaśreṇi, no fullfledged work is known, but his pupil Nīlakaṇṭha Somayāji refers to him as an erudite astronomer and quotes from his writings. Thus, in his *Bhāṣya* on *Āryabhaṭīya* (*Kālakriyā* 17-21), Nīlakaṇṭha says : *tac coktam asmad Ācāryaiḥ* : *sarvatra viṣkambhadalam śrutau vā vyāsārdhake syāt viparītakarṇaḥ* / (Edn., *TSS*, No. 110, p. 47). Further down, in the same context, Nīlakaṇṭha quotes a longer piece with the introductory statement : *nibaddham ca tat tadaiva asmadgurubhiḥ pañcabhir upajātibhiḥ* :

arkasphuṭenānayanam prakuryāt
svamadhyamasyātra vituṅgabhānoḥ /
bhujāguṇam koṭiguṇam ca kṛtvā
mṛgādikendre 'ntyaphalākhyakoṭyoḥ //

bhedaḥ kulīrādigate tu yogas
tadvargayuktād bhujavargato yat /
padam viparyāsakṛtaḥ sa karṇas
trijyākṛtes tadvihṛtas tu karṇaḥ //

tenāhatām uccavihīnabhānor
jīvām bhajed vyāsadalena labdham /
svocce kṣipec cāpi tam ādyapāde
cakrārdhataḥ śuddham api dvitīye //

cakrārdhayuktam tu tṛtīyapāde
saṁśodhitam maṇḍalataś caturthe /
evamkṛtaḥ sūkṣmataras tu madhyaḥ
pūrvam padam yāvad ihādhikam syāt /

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1. On Parameśvara, see : K.V. Sarma, Intro. to his edns. of Parameśvara's works, *op. cit.*; '*Dṛggaṇita* of Parameśvara', (Mal.), *Mathrubhumi W*, 7.10.1956, pp. 29-30; 'Fiftyone years' penance' (Mal.), *Mathrubhumi W*, 7.10.1956, pp. 29-30 ; Raja, 136-43 ; Sen, pp. 166-70 ; Ul. II. 100-5 ; Ul Sup., I. 215-19 ; Va. I. 378-83.

antyāt phalāt koṭiguṇaś caturthe
tv ārabhyate yady adhikātra koṭiḥ |
sarvatra viṣkambhadalam śrutau vā
vyāsārdhake syād viparītakarṇaḥ ||
(*Ibid.*, p. 48)

Elsewhere, too, Nīlakaṇṭha quotes Dāmodara : *E.g.*, *prakārāntareṇa 'candrabāhuphala' ityādinā śrīmad-Dāmodarāhvayāsmadgurumukhodgatena ślokenoktā | (Grahaṇādigrantha*, ms., p. 61). Later writers also mention Dāmodara. Dāmodara might have composed certain works which are yet to be identified, and from which the above-mentioned passages should have been quoted.[1]

25. **Ravi Nampūtiri** (*c*. 1425-1500)

Nīlakaṇṭha Somayāji (1444-1545) mentions in the colophon to his *Āryabhaṭīya-bhāṣya, Gaṇitapāda*, Ravi as his teacher on Vedānta. He pays his respects to Ravi also in the beginning of his *Siddhāntadarpaṇa*. Ravi was also an erudite scholar in Jyotiṣa and has been identified as the author of *Ācāradīpikā*, an elaborate metrical commentary on the *Muhūrtadīpikā*.[2]

26. **Nīlakaṇṭha Somayāji** (1444-1545) : **Nīlakaṇṭha I**

Nīlakaṇṭha Somayāji, the centenarian astronomer of Kuṇḍapura (Mal. Tṛkkaṇṭiyūr) in South Malabar, was, perhaps, as eminent as his grand-teacher, Parameśvara of Vaṭaśreṇi. In a detailed colophon to his *Bhāṣya* on the *Āryabhaṭīya*, *Gaṇitapāda*, he gives full details about himself. Elsewhere also, in his works, he records particulars about his person. He was a Nampūtiri of the Garga-gotra and hailed from the family of Keḷallūr (Mal. Kerala-nal-ūr, Skt. Kerala-sadgrāma). He was the son of Jātavedas and had a younger brother named Śaṅkara. His date of birth is given in the chronogram given in his *Siddhānta-darpaṇa-vyākhyā*, *viz.*, *tyajāmyajñatām tarkaiḥ* (16,60,181) which falls in Dec. 1444. He is referred to as a 'living' authority by Mādhava of Iñcakkāzhvā in his *Praśnasāra*, composed in 1542-43. Both he and his brother Śaṅkara were patronised by Kauṣītaki Āḍhya

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1. On Dāmodara, see Ul. Sup. I. 210-11 ; Va. I. 388. Va. identifies (I. 388) the present author with Dāmodara, au. of *Muhūrtābharaṇa*, but this is not possible, for the former belonged to the Bhārgava-gotra while the latter was of the Bhāradvāja-gotra ; *cf.* the Intro. verse to *Muhūrtābharaṇa* (Ms. Kerala T. 71) : *teṣām viduṣām madhye Bhāradvājagotrajātā ye |*

2. On Ravi, see K.V. Sarma, Intro. to the edn. of *Golasāra*, p. xv ; Ul. II. 113-14.

Netranārāyaṇa (Āzhvāñceri Tamprākkal), the hereditory religious head of the Nampūtiris. Nīlakaṇṭha spent his student days at the house of Parameśvara of Vaṭaśreṇi and received occasional instruction from him, his regular teacher being Parameśvara's son, Dāmodara. Nīlakaṇṭha had also another teacher by name Ravi, who is identified as the author of *Ācāradarśana*.

Nīlakaṇṭha was a versatile scholar, though his writings, which are prolific and erudite, are all on astronomy. His *Tantrasaṅgraha* (A.D. 1500)[1] is a comprehensive treatise on astronomy. His *Grahaṇanirṇaya* and *Candracchāyāgaṇita*, the latter with his own commentary, deal with revised procedures on the respective topics. In his *Golasāra*[2] he gives a résumé of some of his views on certain astronomical topics and in his *Siddhāntadarpaṇa*,[3] he sets out the astronomical constants, as determined by him, the rationale of which he expounds in his commentary on that work. In some elaborate tracts on eclipses and certain other topics (*Grahaṇādigrantha*) he expounds the tradition and rationale of eclipse computation, methods for determining corrections (*saṃskāra-s*) etc. His *Sundararājapraśnottara* forms his answers to certain astronomical problems posed by a contemporary astronomer from the adjoining Tamil region who has commented on the *Vākyakaraṇa* ascribed to Vararuci.[4] Nīlakaṇṭha sets out much original contribution through his extensive *Bhāṣya* on the *Āryabhaṭīya*[5] which is considered to be his masterpiece. But, by far the most instructive work of Nīlakaṇṭha is the *Grahaparīkṣākrama*,[6] where, in about 200 verses, he sets out the procedures for the observation of the planets, sometimes with instruments, and for their computation using the data

1. Ed. with the commentary of Śaṅkara Vāriyar, *TSS*, No. 185 (Trivandrum, 1958).

2. Cr. ed., K.V. Sarma, V.V.R.I., (Hoshiarpur, 1970).

3. Cr. ed., K.V. Sarma, Adyar Library, (Adyar Library, Madras, 1955).

4. Cr. ed., T.S.K. Sastri and K.V. Sarma, K.S.R. Inst., Madras, 1962.

5. Ed. *TSS*, Nos. 101, 110, 185, (Trivandrum, 1930, 1931, 1957).

6. This work has been quoted in full in his *Āryabhaṭīya-bhāṣya*, *Gola*. 48, (*TSS*, No. 185, pp. 132-49). An adapted edition of this has been issued by Puliyur Purushottaman Namputiri, (Bombay, 1950). A perfect ms. of the work is available with K.V. Sarma.

obtained from the observations. A commentary in Malayalam expounding the said procedures is also known.[1]

27. **Śaṅkara of Keḷallūr** (*c*. 1475-1575) : **Śaṅkara I**

Nīlakaṇṭha Somayāji's younger brother Śaṅkara, an astronomer in his own right, was, like his brother, patronised by the Azhvāñceri Tamprākkaḷ, at whose house he was teaching astronomy as mentioned in Nīlakaṇṭha's *Āryabhaṭīya-bhāṣya, Gaṇita*. 26, (edn., p. 156). The said *Bhāṣya* had been composed for the sake of Śaṅkara, who was also entrusted with its propagation.[2]

28. **Citrabhānu** (*c*. 1475-1550)

Citrabhānu Nampūtiri, author of *Karaṇāmṛta*, an advanced manual on astronomical computation in four chapters, was a pupil of Nīlakaṇṭha Somayāji, whom he mentions as 'Gārgya' in the beginning of his work. He belonged to the Gautama-gotra and hailed from the village of Covvaram (Skt. Śivapuram) near Trichur. The date of composition of *Karaṇāmṛta* which is indicated in that work by the Kali chronogram *buddhyonmathyoddhṛtam yatnāt* (16,91,513) (A.D. 1530) gives the clue to its author's date.[3]

29. **Citrabhānu-Śiṣya** (*c*. 1500-75)

Bhāvacintāvali, in three chapters, is a work on astrology by an anonymous pupil of Citrabhānu. That the pupil has written on astrology would suggest that the teacher Citrabhānu, besides being an astronomer, was also an authority on astrology.[4]

30. **Nārāyaṇa I** (*c*. 1500-75)

Nārāyaṇa, disciple of another Nārāyaṇa and Citrabhānu, ardent admirer of Nīlakaṇṭha Somayāji and highly devoted to Subrahmaṇya,

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1. On Nīlakaṇṭha, see : K.V. Sarma, 'Gārgya Kerala Nīlakaṇṭha Somayājin', *Jl. of Or. Res*, 26 (1956-57) 21-39 ; Intro. to the edns. of *Siddhāntadarpaṇa* and *Golasāra, op. cit.*, ; Raja, 143-52 ; Sen, 155-57 ; Ul. II. 117-20 ; Ul. Sup. I. 235-37 ; Va. I. 3 3-87.

2. On Śaṅkara see K V. Sarma, Intro. to *Golasāra, op. cit.*, p. xiii.

3. On Citrabhānu, see Raja, 153-55 ; Ul. II. 273-75 ; Ul. Sup. I. 305-6.

4. On Citrabhānu-Śiṣya, see Raja, 154 (where the work is wrongly called *Bhāvacintāmaṇi*) ; Ul. II.275.

an esteemed associate of Nīlakaṇṭha, was an original thinker and highly informed commentator. He wrote, in A.D. 1529, an instructive commentary called *Laghuvivṛti* on *Pañcabodha IV*.[1] His *Uparāga-kriyākrama* in five chapters is a detailed exposition of eclipse computation. He also wrote two commentaries on the *Līlāvatī*, one short and the other nearly five times as long, both called *Kriyākramakarī* and *Karmadīpikā* (called also *Karmapradīpa* and *Karmapradīpikā* according to the exigencies of the metre of the verses containing these names).[2] The longer *Kriyākramakarī* is especially valuable to the historian of Kerala astronomy and mathematics for the profuse references it contains to earlier authors and authorities, some of which are now lost, and for the theories and procedures enunciated in that commentary.[3]

31. Śaṅkara Vāriyar (*c.* 1500-60) : Śaṅkara II

The author of *Laghuvivṛti* (A. D. 1556), which is an erudite commentary on the *Tantrasaṅgraha*, was a disciple of Nīlakaṇṭha Somayāji and protégé of (Netra) Nārāyaṇa (Āzhvāñceri Tamprākkaḷ), both of whom are mentioned in the beginning of that commentary, is identified with Śaṅkara Vāriyar of Tṛkkuṭaveli family. Though the name of the author is not mentioned in the commentary itself, some manuscripts of that commentary (Kerala Univ. 8351, 8906, C. 524) carry the following post-colophonic statement, in Malayalam, by the scribe : *ī vyākhyānam Tṛkkuṭaveli-c-Caṅkaravāriyar oṭukkattu camaccatu / Āzhvāñcerikku veṇṭiṭṭu sukhame śikṣiccu camacu ennu Paraṅṅoṭṭu paṟaññu keṭṭu /* : 'This commentary was composed last by Tṛkkuṭaveli Śaṅkara Vāriyar. It is stated to have been said by Paraṅṅoṭṭu that it was composed with great care for the sake of Āzhvāñceri'. The person referred to here as Paraṅṅoṭṭu is very likely to be Paraṅṅoṭṭu

1. *Cf.* the chronogram *prajñālokoddhṛtam yas* (Kali day 16,91,302) in the verse at the end of this work :

> *prajñālokoddhṛtam yasmāt gūḍham artham vivṛṇvatī /*
> *vyākhyaivam Pañcabodhasya ciram tiṣṭhatu bhūtale //*

2. Some scholars distinguish between the authors of the two commentaries on the *Līlāvatī* and suggest that Śaṅkara Vāriyar of Tṛkkuṭaveli might have written the longer *Kriyākramakarī* (*cf.* Raja, 155) ; again, some miss to recognize '*two*' *Kriyākramakarī-s* (Ullcor II, 121). The matter has been examined in detail and the authorship of Nārāyaṇa of both the commentaries is being set out by the present writer, elsewhere.

3. On Nārāyaṇa, see Ul. II. 121 ; Ul. Sup. I. 222, 227-28.

Jyeṣṭhadeva, an younger contemporary of Nīlakaṇṭha, and, therefore, the statement is quite likely to be authentic.

Hitherto, Śaṅkara Vāriyar has been credited with the authorship only of the above-said commentary. However, three more of his works can now be identified. Thus, in the beginning of the present commentary, he makes mention of a larger commentary of his on *Tantrasaṅgraha*:

Nārāyaṇām jagadanugrahajāgarūkam
Śrī-Nīlakaṇṭham api sarvavidam praṇamya /
yat Tantrasaṅgraha-gatam grahatantrajātam
tasyā'parām' ca Vivṛtim vilikhāmi Laghvīm //

Again, in the final colophon at the end of the work, he states that the present commentary is an adaptation of a larger commentary of his named *Kriyākalāpa* ('Detailed demonstration') on the *Tantrasaṅgraha. Cf.*:

iti Tantrasaṅgrahasya Kriyākalāpam krameṇa saṅgṛhya /
racite tadvyākhyāne pūrṇo 'bhūd aṣṭamo 'dhyāyaḥ //

A unique manuscript of this longer commentary has been recorded in the Inventory below. It can also be shown that the anonymous work entitled *Karaṇasāra*, in four chapters, whose authorship has been left open (*cf.*, Ul. II. 121-22) and a Malayalam commentary on it which is, at present, attributed to Śaṅkaran Nampūtiri of Mahiṣamaṅgalam (Ul. II. 272, 474), are really the works of Śaṅkara Vāriyar.[1]

32. Jyeṣṭhadeva (*c.* 1500-1610)

Jyeṣṭhadeva, this name being, most probably, the Sanskritised form of his personal name in the local language, has the distinction of

1. Evidences for these identifications are being set out by the present writer elsewhere. Some scholars (*cf.* Raja, 155) ascribe to Śaṅkara Vāriyar the elaborate commentary *Kriyākramakarī* on the *Līlāvatī* on the basis of the similarity of some expressions in one of the introductory verses of that work with those in his commentary on the *Tantrasaṅgraha* However, there are clear evidences, which, as indicated above are being set out elsewhere, to show that the *Kriyākramakarī* is a work of Nārāyaṇa and not of Śaṅkara Vāriyar.

being the author of the popular *Yuktibhāṣā*[1] or *Gaṇitanyāyasaṅgraha*,[2] which forms an elaborate and systematic exposition of the rationale of mathematics in its Pt. I and of astronomy in its Pt. II. The Sanskrit version of this work, known as *Gaṇitayuktibhāṣā*, is also, in all probability, his work. An old astronomical document informs that he was the pupil of Dāmodara of Vaṭaśreṇi and was a member of the Paraṅṅoṭṭu family[3] of the Ālattūr village in South Malabar.[4] Nīlakaṇṭha Somayāji, whose *Tantrasaṅgraha* he mentions towards the beginning of his work, was his respected elder. He himself was the teacher of Acyuta Piṣāraṭi who mentions him in reverential terms at the close of his *Uparāgakriyākrama* (A.D 1592). M. Whish records a tradition that the author of the *Yuktibhāṣā* was the author also of a *Dṛkkaraṇa*[5] The *Dṛkkaraṇa* in question, which is now available in a single manuscript, is a comprehensive metrical treatise in Malayalam on astronomy. It does not give anywhere the name of its author, but gives in its last verse, its date of composition in the words *kolambe barhisūnau* (M.E. 783 = A.D. 1603). In view of this date and the mention of the tradition recorded by Whish, it is quite possible that this is a work of Jyeṣṭhadeva.[6]

33. Jyeṣṭhadeva-Śiṣya (*c*. 1550-1625)

A disciple of Jyeṣṭhadeva, who studied *Tantrasaṅgraha* under him, has composed a metrical commentary on that work ; this

1. Pt. I. ed with elaborate notes by Ramavarma Maru Thampuran and A. R. Akhileswara Aiyar, (Mangalodayam, Trichur, 1948). See also, A. Venkataraman, 'Some interesting proofs from Yukti-bhāṣā,' *Mathematics Student*, 16 (1968) 1-7.

2. An extremely unreliable edition of the whole work has been issued under this title by the Govt. Or Mss. Library, Madras, 1954.

3. An old Malayalam Ms. No. 9886, preserved in the Or. Inst., Baroda, reproduced by K.V. Sarma, in his paper 'Direct lines of astronomical tradition in Kerala', Pt. Charudeva Shastri Felicitation Volume, Delhi, 1972.

4. See Parayil Rāman Nampūtiri, (ed.) *Nampūtirimār*, Trichur, M.E. 1093, (A.D. 1918), p. 65.

5. M whish, 'On the Hindu quadrature of the circle' etc, *Trans. Royal As. Soc.*, 3 (1835) 523.

6. On Jyeṣṭhadeva, see K.V. Sarma, 'Jyeṣṭhadeva and his identification as the author of *Yuktibhāṣā*', *Adyar Lib. Bul.*, 22 (1958) 35-40. On *Yuktibhāṣā*, see Raja, 156-58 ; Ul. III. 439-40 ; Ul. Sup. I. 612-16.

commentary extends, unfortunately, only to the first four of the eight chapters of that work.[1]

34. Māttūr Nampūtiri-s : Puruṣottama I and Subrahmaṇya I (*c*.1475-1550)

Two *Muhūrtapadavī*-s, out of the seven texts that go under that name, have been widely known as the works of two brothers belonging to the Māttūr (Skt. Mahāvastu) family in the village of Paññāḷ (Skt. Pāñcālagrāma), near Chelakkara in Cochin. These two works, comprising, respectively, of 36 and 43 verses, condense in themselves, independently, the prescription of auspicious times for all the major social and religious functions and indication of the baneful times which are to be avoided. Their popularity, as attested by their numerous manuscripts as available and the several commentaries on them is matched only by the obscurity that surrounded the names of their authors. It has now been possible to identify both these writers. A unique manuscript of the first of these two works, preserved in the India Office, London, (Catal. No. 8070), carries a colophon giving the name of its author as Puruṣottama :

V(B)ṛhadāvṛtigehasambhavena dvijarājñā Puruṣottamena |
gurunāthakṛpābalāt kṛtam yat tad idam sadviduṣām mude 'stu nityam ||

With regard to the second of the two works, a hitherto unnoticed commentary thereon available in the Āzhvāñceri Mana (List No. 81) etc., mentions in its introductory verse the name of the author of the text as Subrahmaṇya. *Cf.* :

'vṛddhimdheyād hitāyā'sau savitā vas trayīmayaḥ
yadraśmisambhramād bhānti jyotīṁṣy etāni santatam |
śrīsvarṇabhūmir vidvadbhir sevyā, padyair iyam kṛtā
Muhūrtapadavī yena Subrahmaṇyam praṇaumi tam ||

It is also of interest to note that the first words of the said verse, *viz.*, *Vṛddhimdheyāddhitāya* (16,91,994), gives the date of composition

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1. *Cf.* the concluding verse :

ity eṣa Parakroḍavāsadvijavara-samśrito yo 'rthaḥ |
sa tu Tantrasaṅgrahasya prokto 'dhyāye caturthe 'bhūt ||

The view expressed by some scholars (*cf.* Ul. II. 120, Va. II. 498 and Intro., to the edn. of *Tanrasaṅgraha*, *TSS* 188) that the author of the commentary was a 'Brāhman of the Parakroḍa village' is not warranted by this verse.

of the work as A.D. 1531, enabling the date of the author to be fixed correctly.[1]

35. Nārāyaṇa of Kāṇvavastu (*c.* 15th cent.) : **Nārāyaṇa II**

Nārāyaṇan Nampūtiri hailing from the village of Kāṇvavastu, which is differently identified with Tṛkkaṇṇapuram and Kaṇṇanparampu in Malabar, was the son of Keśava.[2] Nārāyaṇa's *Muhūrtadīpaka* is a comprehensive treatise in about 400 verses on the selection of auspicious times for social and religious functions and has been cited as an authority by Śaṅkara of Mahiṣamaṅgalam (see below).[3]

36. Rudra Vāriyar (*c.* 1475-1550) : **Rudra II**

Rudra (Mal. Uzhuttira) Vāriyar belonged to the Deśamaṅgalam Vāriyam, in South Malabar, which, during the middle ages, was a renowned centre of Sanskrit studies and a rich repository of manuscripts.[4] Rudra wrote in A.D. 1527 his elaborate commentary called *Naukā* or *Vivaraṇa* on Varāhamihira's *Horā*.[5] His other known work is the *Aṣṭamaṅgalapraśna* on a type of astrological query which is very popular in Kerala.[6]

37. Śaṅkara of Mahiṣamaṅgalam (1494-1570) : **Śaṅkara III**

In the matter of the popularisation of studies on Jyotiṣa among the masses in Kerala, Śaṅkaran Nampūtiri of Mazhamaṅgalam

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1. On Māttūr Nampūtiri-s, see K. Sankara Menon, Intro. to his edn. of *Muhūrtapadavī II* with *Bālaśaṅkaram*, *Sri Vanchi Setu Lakshmi Series*, No. 5, (Trivandrum, 1926); Ul. II.110-11 ; Va. II. 601-12.

2. Ulloor (II. 107) suggests that Nārāyaṇa might have been one of the teachers of Parameśvara of Vaṭaśreṇi. But this is not possible, for the name of the father of the present Nārāyaṇa is Keśava (*cf.* : *kaścid dvijo guṇakhyāta-'Keśavākhyadvij-ātmajaḥ' / Kāṇvavastv-āhvayagrāmajanmā Nārāyaṇāhvayaḥ //*), while the name of the father of Parameśvara's teacher Nārāyaṇa was Parameśvara (*cf.* Nilakaṇṭha Somayāji's statement on the subject : *Parameśvaras tu Rudra-'Parameśvarātmaja-Nārāyaṇa'-Mādhavādibhyo golavidbhyo gaṇitagolayuktīr api bālya eva samyag gṛhītvā* etc. (*Āryabhaṭīya-bhāṣya*, *Gola*. 48 ; edn., Pt. III, p. 154).

3. On Nārāyaṇa, see Ul. II 107 ; Va. II. 612-13.

4. For an account of this repository of Mss., see K.V. Sarma, 'Deśamaṅgalam Mss. collection' (in Mal.), *Mathrubhumi Weekly*, (Kozhikode), 8.2.1957.

5. Ed. *TSS*, No 91, Trivandrum, 1926 ; 2nd edn., Trivandrum, 1958.

6. On Rudra, see Ul. II, 114-17 ; Ul. Sup. I. 531-34.

(Skt. Mahiṣamaṅgalam) family had an important part to play. Śaṅkara hailed from the Perumanam village near Trichur but spent most of his active life at Chengannoor with his teacher Parameśvaran Poṭṭi of Vāzha-māveli house. In his work, *Rūpānayanapaddhati*, on grammar, Śaṅkara gives the date of his birth in the chronogram *jātoyam haṁsatulye*('hani) (Kali day 16,78,168), which falls in A.D. 1494.

Śaṅkara wrote a large number of works both on astronomy and on astrology, mostly in simple Malayalam poetry and easy prose. These works include *Gaṇitasāra*, *Candragaṇitakrama* and *Ayanacalanādi-gaṇita* in astronomy, *Jātakakrama* in horoscopy and *Praśnamālā* with *Bhāṣā* in astrological query. A work which he composed in two versions is the *Kāladīpaka*, called in general parlance *Ceriya Kāladīpakam* (Short Kāladīpaka) and *Valiya Kāladīpakam* ('Long Kāladīpaka'). He has a *Jātakasāra* in Sanskrit and another with the same title in Malayalam. He has commented on *Pañcabodha* (II) and *Pañcabodha* (IV).[1] His commentaries on *Laghubhāskarīya*, *Muhūrtapadavī*, *Pañcabodha* IV and his own *Kāladīpaka* II, all called *Bālaśaṅkaram*, have greatly helped the popularisation of these works among the people. On *Pañcabodha* IV, besides the *Bālaśaṅkaram*, he wrote another shorter (?metrical) elucidation entitled *Pañcabo-*

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1. A good amount of confusion has occurred in earlier writings in the identification of Śaṅkara's works. Thus, the *Jātakasāra*, noticed by Ulloor (II. 474) is, really, by a namesake of our author. Our Śaṅkara has actually composed two works under the title *Jātakasāra*, one in Sanskrit and the other in Malayalam; Ulloor does not mention the former and describes the latter as an anonymous work (Ul. III. 241-42), failing to take note of the apparent Mahiṣamaṅgalm characteristics in it. Similarly, Ulloor does not take note of Śaṅkara's *Praśnamālā* and describes Śaṅkara's own *Bhāṣā* on it as an anonymous work (Ul. III. 242). Again, Ulloor describes Śaṅkara's *Bālaśaṅkaram*, called also *Pañcabodhakriyākrama* on *Pañcabodha* IV as the *Pañcabodha* of Śaṅkara, while Śaṅkara's commentary on *Pañcabodha* (II) is not noticed. Certain other works, *viz*, *Bhāṣāsaṅgraha*, *Praśnasāra* and *Karaṇasāra* have also been ascribed to our author but they do not appear to be his works. Of these, *Bhāṣāsaṅgraha* is a commentary by Vāsudeva on *Muhūrtapadavī* V and the *Praśnasāra* and *Karaṇasāra* are the works of different authors named Śaṅkara A detailed study on the identification of Śaṅkara's works is being presented by the present writer elsewhere.

dhārthadarpaṇa. Saṅkara is also reputed to have composed a 'Register of muhūrtas' for a 1000 years.[1]

38. Mādhava of Iñcakkāzhvā (*c.* 1500-75) : Mādhava II

Mādhava was a member of the Nampūtiri family of Iñcakkāzhvā in Rāmamaṅgalam in the Mūvāṭṭupuzha Taluk (Dt. Kottayam). He composed his *Praśnasāra* in A.D. 1543, in 16 chapters, based on earlier works like the *Horā*, but incorporating in it numerous local practices. The work is historically significant for it provides the names of several contemporary astronomical and astrological authorities like Nīlakaṇṭha Somayāji of Keḷallūr, Parameśvaran Poṭṭi of Vāzha-māveli, Attimaṭṭam, Vākkaṭ, Paḷḷimaṭṭam, Mecceri, Koyikkara and Araṇappuram.[2]

39. Acyuta Piṣāraṭi (*c.* 1550-1621) : Acyuta II

Acyuta Piṣāraṭi of Tṛkkaṇṭiyūr (Skt. Kuṇḍapura) in South Malabar, was a versatile scholar and original thinker on astronomy. It was he who enunciated, for the first time, in Indian astronomy, the correction called 'Reduction to the the ecliptic', in his work *Sphuṭanirṇaya* (before A.D. 1593) and set out its rationale, elaborately, in his work *Rāśigolasphuṭanīti.*[3] As pointed out earlier, (see above pp. 12-14), this correction was first introduced in Western astronomy by Tycho Brahe, at about the same time. Acyuta was a protege of King Ravi Varma of Veṭṭattunāḍ (Skt. Prakāśaviṣaya) and was the teacher of the renowned poet and grammarian Melputtūr Nārāyaṇa Bhaṭṭa, who, in the *carama-śloka* which he composed at the death of Acyuta, expressed the date of the latter's demise in the chronogram, *vidyātamā svar asarpat* (17,24,514), which falls in A.D.1621. Acyuta has composed about a dozen works on Jyotiṣa, including *Karaṇottama,*[4]

1. On Śaṅkara, see Koṭṭārattil Śaṅkuṇṇi, 'Muzhamaṅgalattu Nampūri', *Aitihyamālā* IV, (4th edn., Trichur, 1958), pp 89-93; Raja, 155-56; Ul. II. 269-72, 469-75; Va II, 613-22; Ulloor, *Vijñānadīpikā*, (Trivandrum), IV, pp. 187-95.

2. On Mādhava see Ul. II. 475-77. R. Narayana Panikkar (II. 234-35) wrongly describes Mādhava's *Praśnasāra* as a commentary on the well-known *Praśnamārga*. It may be noted that the *Praśnamārga* was composed in 1650, more than hundred years after the composition of *Praśnasāra* (1543).

3. Ed. by K.V. Sarma, Adyar Library, Madras, 1955.

4. Ed. by K. Ragahvan Pillai, *TSS*, No. 213, Trivandrum, 1964.

on astronomical computation, in five chapters, *Uparāgakriyākrama*,[1] and *Uparāgaviṁśati*[2] on eclipse computation, *Chāyāṣṭaka* on shadow computation and *Jātakābharaṇa* (?) and *Horāsāroccaya* on horoscopy. He has commented on the *Venvāroha* of Saṅgamagrāma Mādhava.[3]

Sūryasiddhānta and on his own *Sphuṭanirṇaya* and *Karaṇottama*.[4]

40. **Nīlakaṇṭha (16th-17th cent.) : Nīlakaṇṭha II**

Nīlakaṇṭha II, about whom nothing more is known, is the author of a comprehensive treatise on arithmetic, entitled *Kaṇakku-sāram*, couched in *maṇipravāḷam* verses in Malayalam and a commentary thereon. The author claims to have based his work on Sanskrit texts like the *Līlāvatī* and old Malayalam texts like *Kaṇakkatikāram*. It is noteworthy that, besides the general mathematical procedures, this work deals also with practices relating to local grain transactions, housebuilding, weighing of gold and silver, land tenure, masonry, ground measurement etc.[5]

41. **Nārāyaṇa III**

Laghudarśinī, a short work on astrology, is the work of a Nārāyaṇa, about whom nothing more than his name is known at present.

42. **Dāmodara II** of Maṅgalaśreṇi (*c*. 1575-1675)

In Dāmodaran Nampūtiri of the Maṅgalaśśeri house in Kaṇṇāṭip-parampu in the Chirakkal taluk in N. Malabar, we have a reputed authority in astrology, of the times. His disciples included Iṭakramañceri Nampūtiri, author of *Bhadradīpa* and the anonymous author of *Jyotiṣasaṅgraha* (II), noticed below. Vaṭakkumkūr mentions

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1. This work, in four chapters, contains 130 verses, and not 20 as stated by Raja, 161.

2 Ed. by Rama Varma Maru Thampuran, *Ravivarma Granthāvali*, (Quarterly of the Skt. College, Trippunithura), 2 (1954) i-iii, 16 pp.

3. Ed. by K.V. Sarma, with text, Skt. College, Trippunithura, 1956.

4. On Acyuta, see, S. Venkitasubramonia Iyer, 'Acyuta Piṣāraṭi and his works', *Jl. Or. Res.* 22 (1952-53) 40-46 : K.V. Sarma, Intro. to his edns, of *Rāśigolasphuṭānīti* and *Veṇvāroha*, *op. cit.*; Raja, 158-62; Ul. II. 319-26; Ul. Sup. I. 315; Va. II. 748-57.

5. On Nīlakaṇṭha, see Ul. II. 478-79; Ul. Sup. I. 226-27; Va. IV. 276.

two of his works, *viz.*, *Praśnarīti* (I) and *Līlāvatī-vyākyā*, which, he adds, have been popular. Manuscripts of these works have, however, yet to be identified.[1]

43. Iṭakramañceri Nampūtiri (*c.* 1625-1700)

He is author of *Bhadradīpa-gaṇita* (A.D. 1665) but prefers to remain anonymous and refers to himself only by the name of his family, *viz.*, Iṭakramañceri (or Eṭakramañceri). He mentions his native place as Perumānūr in Malabar and his teacher as Dāmodaran Nampūtiri[2] of the Maṅgalaśśeri family. In eleven chapters, couched in easy Sanskrit-Malayalam verses, he provides the layman with the elements of astronomical computation. A shorter work entitled *Bhūgolañāyam*, composed in the same style and devoted to a description of the earth as suspended in the atmosphere, its main landmarks, the construction of the armillary sphere etc., has much in common with Ch. V of the *Bhadradīpa* and is likely to be another composition of our author.[3]

44. Maṅgalaśreṇīvipra-Śiṣya (17th cent.)

An author, who does not give out his name and describes himself as a pupil of a Nampūtiri of the Maṅgalaśśeri family, has composed, in Malayalam, a *Jyotiṣasaṅgraha* (II). The Maṅgalaśśeri Nampūtiri in question is very likely to be the same as the Dāmodaran Nampūtiri, author of *Praśnarīti* I and teacher of Iṭakramañceri Nampūtiri, noticed above.

45. Panakkāṭṭu or Iṭakkāṭṭu Nampūtiri (*c.* 1625-1725)

The *Praśnamārga*, the most popular and authoritative work on *praśna* in Kerala, was composed in about A.D. 1650 (*cf. kolambe 'muraha'-saṅkhye*, M.E. 825) by a Nampūtiri of the Panakkāṭṭu family. Since his family was situated in a place called Iṭakkāṭ (or Eṭakkāṭ) (Skt. Madhyāṭavī or Madhyāraṇya), in North Malabar, he was known by that name as well. K. Mahadeva Sastri gives the name of the

1. On Dāmodara, see Va. III. 378-79.

2. Va. III. 379 takes the word 'Dāmodara' occurring in the Intro., verse 2 of the *Bhadradīpagaṇita* as the author's name on the basis of the wrong reading 'Dāmodaro', instead of that of his teacher, as per the correct reading 'Dāmodaram'.

3. On this author, see Ul. III. 232-34.

author as Parameśvara, on what grounds it is not known.[1] The author gives the name of his parents as Mahādeva and Śrī. In 32 chapters, the work presents a detailed exposition of the different topics and types of *praśna*. The author has also supplied a lucid exposition called *Durgamārthapradarśinī* on the work. It has several commentaries in Malayalam also, including some produced during modern times. Panakkāṭṭu Nampūtiri is said to have composed in 1676 a work on astronomy, which is not available now.[2]

46. **Iṭakkāṭṭu** (or **Eṭakkāṭṭu**) **Kukkaṇiyāl** (*c.* 1675-1750)

The personal name of this author seems to be Śaṅkaran Kaṇiyār. He belonged to the house of Kaṇiyāṅkaṇṭi in Eṭakkāṭ in North Malabar and studied astrology under Panakkāṭṭu Nampūtiri. In later life, he came under the influence of a Yogi and spent his life in meditation. His *Praśnarīti*[3] in 20 chapters is very popular among astrologers of the Kaṇiyār caste. In its first twelve chapters, it is a free metrical rendering in Malayalam of his teacher's *Praśnamārga* and deals, in the remaining eight chapters, with other allied and miscellaneous matters.[4]

47. **Rāma-śiṣya** (17th cent.)

Manuscripts of a free explanatory rendering, in Malayalam verses, of the *Laghujātaka* or *Laghuhorā* of Varāhamihira, called *Laghuhorāvivaraṇam* have been identified. The author does not reveal his name but mentions his teacher Rāma and the date of composition of the work, *viz.*, A.D. 1640. The author says in the beginning of the work that he had already composed a *Horāsāra* in Malayalam, possibly a free explanatory rendering, like the present work, of the *Horā*.

48. **Puruṣottama II** (*c.* 1650-1725)

A unique manuscript of the *Uparāgapariccheda* of a *Pañcabodhaśataka* (*Pañcabodha* V) is known. In 47 verses, this section of the work sets out the computation of solar and lunar eclipses, using its own

1. See his *Des. Cata. of Skt. Mss. in the Curator's Office Library, Trivandrum*, vol. IV, (Trivandrum, 1939), p. 1539.

2. On Panakkāṭṭu Nampūtiri, see Ul. III. 87-89 ; Va. III. 400-5.

3. Ed. serially in the *Kavanodayam* (Mal. monthly, Kozhikode).

4. On this author see Ul, III. 236-37 ; Ul. Sup. I. 536 ; Va. III.405-6.

revised multipliers, divisors and other constants. For the calculation of the precession of the equinox, it mentions the epoch *prauḍhaśrī-guṇasevya* (17,53,242). This date works out to A.D. 1699 and gives a clue to the date of the author.[1]

49. Putumana Somayāji (*c.* 1660-1740)

The *Karaṇapaddhati*,[2] in ten chapters, is a comprehensive treatise on astronomy by an anonymous Somayāji of the Putumana or Putuvana (Skt. Nūtanagṛha or Nūtanavipina) family of Śivapuram (Trichur). The availability of manuscripts of the work in Tamil and Telugu scripts indicate its popularity in those regions as well. The work has been commented in Malayalam,[3] Sanskrit and Tamil. Its date of composition is said to be given in the concluding verse of the work by the chronogram *gaṇitam etad samyak* (17,65,653) which falls in A.D. 1732.[4] While *Karaṇapaddhati* is the best known work of the author in Jyotiṣa, it has been shown that he has written certain other works also in that discipline.[5] In *Nyāyaratna*, he deals, in eight chapters, with certain aspects of *Sphuṭa*, *Vikṣepa*, *Chāyā*, *Viparītacchāyā*, *Grahaṇa*, *Śṛṅgonnati*, *Mauḍhya* and *Vyatīpāta*. The object of writing the work is expressed in its concluding verse thus :

nyāyapradarśanāyaivam gaṇiteṣvalpacetasām |
gaṇitābdhau nimajjyaitat Nyāyaratnam mayoditam ||

'This *Nyāyaratna* has been composed by me by delving into the depths of astronomy for demonstrating astronomical rationale to the dullwitted.'

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1. On Puruṣottama, see Ul. Sup. I. 224-25.

2. Ed. *TSS*, No. 126, (Trivandrum, 1937) ; with two old Malayalam commentaries, *Madras Govt. Or. Ser.*, No 98, (Madras, 1956) ; with a modern commentary by P.K. Koru, (Astro Press, Cherp, Kerala, 1953).

3. See fn. above.

4. Some scholars like Ulloor (II. 107-8) and Vaṭakkumkūr (I. 529-30) have held that this work was written in A D. 1430. For a refutation of this view and for conclusive evidences for a much later date, see K. V. Sarma, 'The date of Putumana Somayāji', (Mal.). *Mathrubhūmi W*, ' (Kozhikode), 5. 2. 1956. It has also been argued that the said chronogram, which according to the tradition recorded by Whish is the date of composition of the work, may not be so. However, in view of date indicated by the evidences set out in the said paper, there is no incongruity in believing the tradition.

5. On these, see K. V. Sarma, 'The hitherto unknown works of Putumana Somayāji' (Mal.), *Mathrubhūmi W*, *ib.* 29.1.1956.

The *Nyāyaratna* occurs in two versions, which differ slightly by the presence or absence of certain verses and in the arrangement thereof. The *Veṇvārohāṣṭaka* of Putumana Somayāji is a manual for the accurate determination of the moon at short intervals. His *Pañcabodha* III[1] is a practical manual for the computation of *Vyatīpāta*, *Grahaṇa*, *Chāyā*, *Śṛṅgonnati* and *Mauḍhya*. *Grahaṇagaṇita* IV commences with the characteristic introductory verse of Putumana Somayāji, *viz.*, *madīya-hṛdayākāśe* etc. and so is likely to be his work. So also *Grahaṇāṣṭaka* II, which, though a self-contained work, forms a part of the said *Grahaṇa-gaṇita*. K. Rama Varma Raja makes mention of a tradition which attributes to our author a work called *Mānasagaṇitam*.[2] This is likely to be the Malayalam commentary on (*Laghu*)*mānasa* which has now been identified and whose introductory verse contains words reminiscent of Putumana Somayāji's expressions. In horoscopy, he wrote the highly popular *Jātakādeśa*(*marga*)[3] which is known in two recensions, both of which might have been written by him.[4]

50. Vāsudevasvāmi : Vāsudeva I

Vāsudevasvāmi, who describes himself as a devotee of Viṣṇu, is the author of a treatise entitled *Kāladīpa*, dealing, mainly, with natural astrology. It is preserved in a unique manuscript procured from the Punnattūrkoṭṭa Mana, Koṭṭappaṭi, in Malabar. It is a comprehensive treatise dealing with a wide range of topics, which the author enumerates towards the beginning of his work.[5]

51. Śyāmalavāraṇarāja

The *Kāladīpa* of Vāsudevasvāmi has an elaborate commentary which gives the name of its author as Śyāmalavāraṇaraja. The

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1. Included in the *Jyotiśśāstrasubodhinī*. Pt. II, by Punnaaśśeri Nīlakaṇṭha Śarmā, (Triśśivaperur, M. E. 1104) and in *Pañcabodham Bhāṣā*, ed. by Kanippayyoor Sankaran Namputirippad, Kunnamkulam, M.E. 1107.

2. 'The brahmins of Kerala', *Jl. of the Royal As. Soc.*, 1910, p. 635.

3. Pub., Panchangam Press, Kunnamkulam, 5th edn., M. E. 1125; A.R.P. Press, Kunnamkulam, M.E. 1105.

4. On Putumana Somayāji, see K. V. Sarma, 'Putumana Somayāji', Proc. All-India Or. Conf., 18th Session, Annamalainagar, 1956, pp. 562-64; Intro. to *Karaṇapaddhati*, *op. cit.*, (Madras), pp. xxi-xxxi: Raja, 162-65; Ul. II. 107-9; Ul. Sup. I. 212-15; Va. I. 529-31; A. K. Bag; 'Trigonometrical series in the *Karaṇapaddhati*, etc.', *Indian Jl. of Hist. of Sc.*, 1 (1966) 98-106.

5. On *Kāladīpa*, see Va. III. 392-94.

name is obviously the Sanskritisation of the author's Malayalam name. Since he describes himself as a 'rājā' and a manuscript of the work has been found only in in the palace of Punattūrkoṭṭa, it is likely that the author is a member of that household.[1]

52. Dāmodara of Bhāradvāja-gotra : Dāmodara III

He was a Nampūtiri who hailed from a village east of Tṛpparaṅṅoṭ in Malabar and was the brother of Keśava, who was also his teacher. Two earlier scholars of his family were Yajña and Yajña's son Dāmodara. The *Muhūrtābharaṇa* of our author is an exhaustive text in nine chapters, devoted, respectively to : definitions, merits of neutral times, demerits of baneful times, merits of auspicious occasions, comparative potencies, auspicious times for : (a) religious functions beginning with *niṣeka* to marriage, (b) agriculture, consecration etc., (c) royal installations and (d) miscellaneous functions. A special distinction of the *Muhūrtābharaṇa* is that it provides very readable poetry from a deft-handed poet.[2]

53. Kṛṣṇa II

The *Āryabhaṭīya* has a commentary in Malayalam by an author whom its only known manuscript (India Office 6273) labels as Kṛṣṇa. He is different from Kṛṣṇadāsa, another commentator (see below), as shown by the difference in the beginning of the two commentaries.

54. Keralīya-dvija

An author who calls himself merely as Keralīya-dvija and does not give out his real name has written a good Malayālam commentary on the *Karaṇottama* of Acyuta Piṣaraṭi. No personal detail is known about this author.

55. Govinda-śiṣya

There is an anonymous author who describes himself as a devotee of Lord Śiva at Vaikkam (Skt. Vyāghra-grāma) in Central Kerala and as a pupil of Govinda. He has composed an elucidatory and highly popular commentary called *Bālabodhinī* or *Bālaprabodhinī* on the

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1. On *Kāladīpavyākhyā*, see Va. III 393.

2. On Dāmodara, see Ul. II. 105-6 ; Ul. Sup. I. 210-11 ; Va. I. 383. Va's equating our Dāmodara of the 'Bhāradvāja gotra' with Dāmodara of Vaṭaśreṇi, who belongs to the 'Bhārgava gotra' is, obviously, not correct. So also his suggestion that Keśava was the father and not the brother of Dāmodara as found in the original manuscript of the work.

Jatakapaddhati of Parameśvara of Vaṭaśreṇi. His teacher Govinda is identified, generally, as Govinda Piṣāraṭi of the Kailāsapuram house near Vaikkom.[1]

56. **Veṇāḍ-brāhmaṇa**

The *Jātakodaya* is a succinct work on astrology in 103 verses, whose author does not give out his name, but styles himself as a brāhman of Veṇāḍ.[2] Veṇāḍ, as is well known, is the name of the southern part of the erstwhile State of Travancore in Kerala.

57. **Azhvāñceri Tamprākkaḷ** (*c.* 1725-1800)

The painstaking enterprise and zeal for propagating, among the Nampūtiris, studies on Jyotiṣa, evinced by a member of the Āzhvāñceri Tamprākkaḷ's family is apparent from his series of adapted texts and extensive commentaries thereon, covering the entire field of astronomy and astrology in eleven books. In the penultimate volume of the said works, *viz.*, *Phalasārasamuccaya-Bhāṣā*, while setting out his objectives, he makes a mention of his earlier works : "In the Malayalam area, those who are not eligible to learn Jyotiṣa study it. And, brāhmaṇas ask them about *muhūrta*, *praśna* etc. Since neither of these is proper, I, with a view to change this state of affairs through making the brāhmaṇas learn Jyotiśśāstra, summarised the most essential matters thereof in the *Jyotiśśāstrasaṅgraha* and, also prepared a commentary in Sanskrit-Malayalam on this *Saṅgraha*. Later, in order to enable the understanding of the working of the matters set out in the *Saṅgraha*, a *Saṅgrahasādhanakriyā* was written and also a Malayalam commentary thereon. Then I compiled the *Jātakasārasaṅgraha* and its Malayalam commentary. Then, in order to be of help in the drawing of horoscopes, I wrote the *Jātakanītimārga* and a Malayalam commentary on it. Later, with a view to enable an understanding of the results of astrological aspects, I compiled the work entitled *Phalasārasamuccaya*. Now, I am writing the present work, being its Malayalam commentary." The *Jyotiśśāstrasaṅgraha* is a résumé on the essentials of practical astronomy and astrology (text, 650 granthas ; *Bhāṣā* 1700 gr.) is in two parts : I. *Siddhāntaskandha* or *Gaṇitaskandha*, on astronomy and II. *Horāskandha*, comprising of Muhūrta, Jātaka and Praśna. The *Saṅgrahasādhanakriyā* (text, 150 gr. ; *Bhāṣā*, 600 gr.) is intended to indicate the working of the matters set out in the *Jyotiśśāstrasaṅgraha*.

1. On this work see, Ul.III. 89-90 ; Ul. Sup. I. 464 ; Va. III 382-83.
2. The actual expression is : *dvijena...dvi* (?) *Veṇāṭikadeśajanmanā*.

The *Jātakasārasaṅgraha* (text, 230 gr.) in six sections and the *Jātakanītimārga* (text, 200 gr. ; *Bhāṣā*, 1300 gr.) in fourteen sections are complementary texts on horoscopy. The *Phalasārasamuccaya*, the author's *magnum opus*, (text, 1300 gr.; *Bhāṣā*, 21,000 gr.), is an extensive work in three sections, devoted, respectively, to Jātaka, Praśna and Muhūrta. The Tamprākkaḷ wrote also a detailed commentary called *Tamprākkaḷ Bhāṣā* in Malayalam on *Muhūrtapadavī* II.[1]

The author does not give out his personal name anywhere in his works, but gives his family name, *viz.*, Āzhvāñceri Tamprākkaḷ.[2] Some of the manuscripts of his works are dated. The earliest of these dates, *viz.*, A.D. 1756, which is possibly, the date of composition of the work, occurs in a manuscript of *Gaṇitasārasaṅgraha* Section of *Jyotiśśāstrasaṅgraha*, Kerala C. 2183-I. This provides a clue to the author's date, which might be put as *c.* 1725-1800.

58. Vāsudeva of Vaḷḷimana : Vāsudeva II

Vāsudeva hailed from **Kaṇṇamaṅgalam** and wrote a metrical commentary on a hitherto unrecognised *Muhūrtapadavī* (V) beginning with the words *cakrārdham mṛtivaidhṛtam ca gulikaḥ*. Two versions of this commentary, which is called *Bhāṣāsaṅgraha*, are known, one in 178 verses and the other in 185 verses ;[3] to all appearances, Vāsudeva himself has effected this revision.[4]

59. Tuppan Nampūtiri of Iṭavaṭṭikkāṭ (*c.* 1725-1800)

Tuppan Nampūtiri was a member of the Iṭavaṭṭikkāṭ family of

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1. Pub. Keralakalpadruman Press, Trichur.

2. One of the ms. of *Jyotiśśāstrasaṅgraha-Bhāṣā* (Kerala C. 2197-A) has the name of Kaypañceri Tamprākkaḷ mentioned in the post-colophonic statement, though, without being 'specifically' stated as the author.

3. *Cf.* the concluding verses of the two versions :

i. *'dāsakṛt'* (178) *ślokasaṅkhyā ca Vāsudevena nirmitā* /
Vaḷḷimanṟu gṛham, deśam collinṟu Kaṇṇamaṅgalam // and

ii *'mandāyuḥ'* (185) *ślokasaṅkhyā ca Vāsudevena nirmitā* /
Vaḷḷimanṟu gṛham, deśam collinṟu Kaṇṇamaṅgalam //

4. Ulloor, inconsiderate of the contents of this work and the colophon (as above) at the end, wrongly takes (Ul. II. 272, 473) this work as an independent treatise and ascribes it to Śaṅkara of Mahiṣamaṅgalam on the basis of a superficial similarity of its introductory verses with those in the works of Śaṅkara.

Pāṅkode in Kunnathunad taluk, Dt. Kottayam, and was patronised by Maharaja Rāma Varmā, surnamed *Dharmarāja*, of Travancore. He was also a poet of some merit. His work on Jyotiṣa is *Muhūrtapadavī* VI, in 40½ verses.[1]

60. Nārāyaṇa of Iṭavaṭṭikkāṭ (*c.* 1728-1800) : **Nārāyaṇa IV**

Nārāyaṇan Nampūtiri of Iṭavaṭṭikkāṭ family was the younger brother of Tuppan Nampūtiri and was, like his brother, patronised by *Dharmarāja* of Travancore. He too was a poet of merit, both in Sanskrit and Malayalam and has left some exquisite writings. He wrote in Jyotiṣa *Muhūrtapadavī* VII, in 36 verses.[2]

61. Parameśvara II

The *Praśnaṣaṭpañcāśikā* of Pṛthuyaśas and the *Horā* of Varāhamihira have concise commentaries called *Pārameśvarī* by a Parameśvara who has to be distinguished from his namesakes. In the commentary on the *Horā*, which is also called *Horābhiprāyanirṇaya*,[3] Parameśvara often adds his own explanatory verses in elucidation of the text.

62. Parameśvara, pupil of Śaṅkara : Parameśvara III

The *Horā* of Varāhamihira has a commentary called *Jātaka-candrikā* or *Viśvārthadīpinī* by a Parameśvara who describes himself as a disciple of a Śaṅkara, but about whom nothing more is known.[4]

63. Bhāradvāja-dvija (*c.* 1750-1800)

An astronomer who calls himself merely as *Bhāradvāja* has composed two important works, *viz.*, (1) *Gaṇitayuktayaḥ*, which sets out the rationale of several mathematical and astronomical procedures and (2) *Karaṇadarpaṇa*, an advanced manual for astronomical computation. The former work cites frequently a 'Bhāṣyakāra' who is, obviously, Nīlakaṇṭha Somayāji, Jyeṣṭhadeva, the author of *Yuktibhāṣā*,

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1. On Tuppan Nampūtiri, see Ul. III. 470-76.
2. On Nārāyaṇa, see Ul. III. 470-76.
3. Ed. by K. Raghavan Pillai, *TSS*, Trivandrum, 1963.
4. On this author, see Va. III. 394.

and *Nyāyaratna*, most probably, the work of that name by Putumana Somayāji. The *Karaṇadarpaṇa* has been commented in Malayalam.

64. Nārāyaṇa of Perumanam: Nārāyaṇa V

Nārāyaṇan Nampūtiri of Perumanam village, near Trichur, is the author of an astronomical treatise entitled *Tantrasāra*. There is also a Malayalam commentary available on the work.[1]

65. Kṛṣṇadāsa (Koccukṛṣṇan Āśān) (1756-1812)

Koccu-kṛṣṇan Āśān was born in the family of Neṭumpayil in the Tiruvalla taluk of Kerala, as the son of an erudite astrologer named Rāman Āśān. He studied Jyotiṣa under his father as also under Śūlapāṇi Vāriyar of Kozhikode. He came of a long line of astronomers and astrologers and had several disciples who continued that tradition.[2] He was a great devotee of God Kṛṣṇa and was a poet with several works to his credit. His works on Jyotiṣa, all intended for the novice, include *Pañcabodha* VIII, in Malayalam verse, *Bhāṣājātakapaddhati*, being a free rendering-cum-commentary of the popular *Jātakapaddhati* of Parameśvara of Vaṭaśreṇi, incorporating several matters not dealt with in the original.[3] *Kaṇakkuśāstram* presenting mathematical procedures in Malayalam verse and a *Bhāṣā-Golayukti* which he mentions in his *Bhāṣājātaka-paddhati* as a work which he intended to write but which yet remains to be traced.

A hitherto unknown work of Kṛṣṇadāsa is a commentary in Malayalam prose on the *Āryabhaṭīya*. The commentary is elucidative and quotes several authorities including Bhāskara I, *Laghubhāskarīya*, Saṅgamagrāma Mādhava, Parameśvara of Vaṭaśreṇi, *Karaṇapaddhati* and a *Prakāśikā* which remains to be identified.[4] A Malayalam

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1. On this, see Raja, 153.

2. *Vide* above, pp. 5-6.

3. Ed. by K. Sankara Menon, *Bhāṣājātakapaddhati*, *Sri Vanchi Setu Lakshmi Series*, No. 3, Trivandrum, 1926.

4. The relevent quotation occurs in the com. on *Gītikā* 5 and gives the number of Kalpa days up to the beginning of Kali: *Prakāśika enna granthattil varttamānakaliyugattil ninnu munpu aṭṭaṅṅalāya kalpadivasaṅṅaḷ 'śarāśviṣaṭkhādriśarādrivedakṛteṣuyugmasvara-sammitāḥ syāt'* (7,25,44,75,70,625) *ennu paṭhikkappeṭṭiṭṭumuṇṭu.*

quotation from Parameśvara[1] poses a problem, for all known works of Parameśvara are in Sanskrit. Possibly, Parameśvara has written also in Malayalam or the passage in question is only a view of Parameśvara expressed in Malayalam.[2]

66. **Śaṅkara of Muktisthala** (17th cent.) : **Śaṅkara IV**

This author was a Nampūtiri who hailed from Mūkkola (Skt. Muktisthala) in North Malabar. He refers, in his works, to Nārāyaṇa, his teacher on Jyotiṣa, and to his patron, the Zamorin of Kozhikode. In his *Mantrasāra*, he says that the name of his house was 'Rājakula' (Mal. ?) and that he imbibed his knowledge in *mantraśāstra* from Dāmodara, son of Nīlakaṇṭha of the Bhāradvāja-gotra, who belonged to Kuṇḍapura (Mal. Tṛkkaṇṭiyūr).[3] He wrote, on natural astrology, the *Sāmudrasāra*, called also *Ārūḍhapraśna* and *Lāñchana-śāstra*, a comprehensive work which dealt with omens, palmistry, astrological query etc. He is the author also of another work, in Malayalam *maṇipravāḷa* verses, tentatively entitled *Āyuḥpraśna*, but dealing, besides *Āyus*, with *Aṣṭamaṅgala*, *trisphuṭa*, *viṣṭi* etc.[4]

67. **Śaṅkara V**

A Śaṅkara, about whom little personal details are available, is the author of two works, entitled *Jātakasāra* (III) and *Praśnasāra* (I).[5] Both are in Malayalam prose interspersed with Sanskrit verse and have four chapters each. The former deals with the main topics of practical astrology starting from the drawing of a horoscope, and the latter with astrological queries relating to age, marriage, children and profit and loss. He is, probably, the author also of *Praśnānuṣṭhana-paddhati*, which occurs in two versions, I and II.

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1. *Cf.* : *'iviṭe yojanakarṇam candranṟe madhya-yojanakarṇam ākunnu' enniṅṅane Parameśvarācāryar paraññiṭṭumuṇṭu.*

2. On Kṛṣṇadāsa, see Ul. III. 519-27 ; Ul. Sup. I. 647-48 ; Va. III. 384-85.

3. For extracts, see Va. II. 719.

4. On Śaṅkara, see Ul. III. 86-87 ; Va. II. 718-23.

5, Ulloor does not notice this *Jātakasāra*, which is different from its namesake by Śaṅkara of 'Mahiṣamaṅgalam'. Of *Praśnasāra* II, Ulloor (II. 473) takes Mahiṣamaṅgalam Śaṅkara as the author. This is unlikely, for this work does not bear any of the characteristic *mudrās* of the Mahiṣamaṅgalam author.

68. Bhūtanāthapura-Somayāji

An anonymous Somayāji of Bhūtanāthapura, who was a disciple of Vaidyanātha has composed a comprehensive work on astrological query, entitled *Praśnasāra* (III).

69. Śaṅkara VI

Śaṅkara, about whom nothing more is known than his name, has composed a commentary in Malayalam to the *Praśnasāra* III of Bhūtanāthapura-Somayāji.

70. Śrīkumāra, son of Nīlakaṇṭha

Śrīkumāran Nampūtiri, son of Nīlakaṇṭha and pupil of Nārāyaṇa, is the author of *Praśnāmṛta*, a succinct work on astrological query. The author is good at versification and writes in a pleasing language. He mentions his village as 'Dvipakānana' (? Mal. Ānakkāṭ).

71. Nārāyaṇan Iaiyatu of Maccāṭ (1765-1843) : Nārāyaṇa VI

Nārāyaṇan Iḷayatu was a member of the Chāntampiḷḷi family in Maccāṭ near Cochin. He was a gifted poet, author of several poems in Sanskrit and Malayalam and a resourceful astrologer whose predictions have developed into legends.[1] He was patronised by the royal house of Cochin, especially by Śaktan Thampurāṇ. In Jyotiṣa, he wrote the *Jyotiṣabhāṣāvali*, called also *Maccāṭṭu-Bhāṣa*, being an introduction to astrology, and the *Jātakādeśaratna*,[2] based on the *Jātakādeśamārga* of Putumana Somayāji.[3]

72. Parameśvara of Puradahanapura (c. 1775-1839) : Parameśvara IV

Parameśvara, disciple of Agnidatta, was a member of the Nampūtiri family of Purayannūr (Skt. Puradahanapura), in the Vaḷḷuvanāṭ taluk of South Malabar. He was a poet of merit and is the author of two long poems in Malayalam. His significant contribution

1. Several of these feats are described by Puthezhathu Rama Menon in his book *Śaktan Thampurān*, (Mangalodayam, Trichur).

2. Manuscripts of this work are yet to be recovered, but the work is referred to by Puruṣottama III, the grandpupil of our author, in his *Praśnāyana*, III.19, VIII 88, XV. 41.

3. On Nārāyaṇa, see Kuṭṭamaśśeri Nārāyaṇa Pishāroṭi, 'The works of Maccāṭṭu Iḷayatu' (Mal.), *Sahitya Parishat Traimāsikam* (Ernakulam) 9 (M.E. 1119) 130-31, Ul. III 527-29; Ul. Sup. I. 648-49; Va. IV. 216-21.

to Jyotiṣa is his commentary *Varadīpikā*, composed, in A.D. 1815 (*cf.* '*naḷadhi*'-*saṅkhya-kolambe*, M.E. 990), on the *Muhūrtapadavī* II of Māttūr Puruṣottaman Nampūtiri. This commentary is highly elucidative, profusely documented and extremely elaborate, in 2000 granthas for a text of 35 verses. One of the important works quoted by Parameśvara is the *Prācīna-Muhūrtapadavī* (*Muhūrtapadavī* I), supposed to have been written by Govinda Bhaṭṭatiri of Talakkuḷam.[1]

73. Śrīkaṇṭha Vāriyar of Veḷḷārakkāḍ

The popular *Jātakapaddhati* of Parameśvara of Vaṭaśreṇi has a lucid commentary in Malayalam which has been made available in print in a slightly adapted form by Kanippayyoor Sankaran Namputirippad.[2] The edition contains a verse, carried over from the original manuscript, to the effect that it was written (*likhitavān*) by Śrīkaṇṭha, a 'devadāsa' of Śvetagrāmaṭavī (Mal. Veḷḷārakkāḍ). It is not definite, however, whether Śrīkaṇṭha was only the scribe or the real author.

74. Ghaṭigopa (*c.* 1800-60)

Ghaṭīgopa, which is, presumably, not his real name but only the Sanskritisation of his personal or popular name,[3] calls himself a disciple of Parameśvara and a devotee of God Padmanābha, the presiding deity of Trivandrum. His contribution to astronomy is in the form of two commentaries, one in Sanskrit and the other in Malayalam, on the *Āryabhaṭīya*. The commentary in Malayalam occurs in two

1. On Parameśvara, see Ul. III. 476-77 ; Ul. Sup. I. 627 ; Va. II. 605-12.

2. Pub. under the title *Balapiṇḍavum āyurdāyavum*, Kunnamkulam, M.E. 1102 (A.D. 1927).

3. The South Indian village accountant is called *Maṇiyakkāran* ; this term, which can be rendered, literally, as 'clock-man' could give rise to the Sanskritisation 'Ghaṭīgopa'. To hazard another specific suggestion : Prince Goda Varma Koyittampurān (1810-60), a member of the scholarly family of Kilimanoor and a resident of Trivandrum, had the distinction of constructing, all by himself, a clock, and, thereby, getting as present a golden bracelet from the reigning ruler of Travancore (Ul. IV. 57 ; RNP V. 21). Following this achievement, he gained the popular appellation 'Maṇikkāran Thampurān' ('Prince of the clock'). This prince was also a good astronomer. Can it be that he composed the commentaries on the *Āryabhaṭīya* under the Sanskritised version of his name 'Ghaṭīgopa' ? In that case, the date arrived at on the basis of internal evidence (see below) and the author's being a devotee of God Padmanābha, would fit in well.

distinct versions, the longer one being nearly one and a half times in extent as the shorter. In the shorter version, under *Kālakriyā* 4, Ghaṭīgopa gives the rationale for the 248 *candra-vākyas*. An indication of his date is given by his mention of Putumana Somayāji's (1675-1750) *Pañcabodha, Chāyākhaṇḍa* 10, in the said shorter version of his commentary. Ghaṭīgopa might, for this reason, be palced after 1800.[1]

75. Goda Varmā, Vidvān Iḷaya Tampurān (1800-51)

Among the renowned scholars and patrons of literature produced by the scholarly royal house of Koṭungallūr, near Cochin, Goda Varmā, better known as Vidvān Iḷaya Tampurān, occupies a place in the front rank. He was a versatile scholar and has written profusely, both in Sanskrit and in Malayalam. In astronomy he has produced erudite commentaries in Sanskrit on the *Gaṇitādhyāya (Bhāskarīya-gaṇita)* and the *Golādhyāya* of the *Siddhāntaśiromaṇi* of Bhāskara II.[2]

76. Śaṅkara Varmā of Kaṭattanāṭ (1800-38)

Prince Śaṅkara Varmā, known also as Appu Tampuran, belonged to the royal house of Kaṭattanāṭ in North Malabar. He was an astute astronomer and his *Sadratnamālā*,[3] in six chapters, is a compendium of the Kerala school of mathematics and astronomy. The date of composition of the work is indicated in the concluding verse of the work by the chronogram *lokāmbe siddhisevye* (17,97,313), which falls in A. D. 1823. The author himself has written an elaborate commentary on the work, which, however, extends only up to verse 32 of the last chapter.[4]

77. Subrahmaṇya Śāstrī (1829-88)

Subrahmaṇya Śāstrī was a versatile scholar who hailed from the village of Nalleppalli in Chittur taluk (Cochin). His erudition extended to different disciplines, including Jyotiṣa, Mantraśāstra, Viṣavaidya,

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1. On Ghaṭīgopa, see Ul. III. 234-35 ; Ul. Sup. II. 535.

2. On Goda Varmā, see Ul. IV.31-44 ; Ul. Sup. II.19-23 ; Va. IV. 315-44.

3. Ed. with auto-commentary, in *Kavanodayam*, (Mal. monthly, Kozhikode), vol. 16 (1898).

4. On Śaṅkara Varmā, see Raja, 165-66 ; Sen, 191 ; Ul. III. 499-501 ; Ul. Sup. I. 635-37 ; Va. IV. 384-93.

Music and Dramaturgy, and has, to his credit, several works in Sanskrit, Malayalam and Tamil. His contribution to Jyotiṣa is his *Agaṇita* (A.D. 1851) which enunciates procedures to compute the planets for a thousand years.[1]

78. **Subrahmaṇya of Kunnattu Mana** (1835-1903) : **Subrahmaṇya II**

Subrahmaṇyan Tirumunpu was a member of Kunnattu Mana of Bhūtanāthapura (Payyanur) in North Malabar. He wrote a commentary called *Bhāvaprakāśaka* on the *Muhūrtadarśana Vidyāmādhava.* This commentary is very extensive, though it has not grown popular.[2]

79. **Puruṣottaman Mūssatu** (*c.* 1850-1900) : **Puruṣottama III**

Puruṣottaman Mūssatu of Kūttaleṭattu Mana is the author of *Praśnāyana*,[3] a comprehensive work in 1018 verses, distributed in fifteen sections called *ayana*'s, composed in A.D. 1881.[4] The author mentions, at the beginning of his work, his teachers as Bhāskara, Śaṅkara, Vahni and Nārāyaṇa and, at the close, he indicates the inspiration behind its composition :

> *Madhyāraṇyadvijāsyād vigalita iha yaḥ Praśnamārgo 'marādau'*
> *kolambe, chātraśiṣyo 'sya ca viracitavān Jātakādeśaratnam |*
> *tacchiṣyasyānumatyā Sthalipuranilayasy 'Āyanam' 'Praśna'to 'sau*
> *Sṛprā-deśādhivāsī vyaracayam aham apy 'Uttamaḥ Pūruṣāṇām' ||*

According to this statement, Madhyāraṇyadvija (Iṭakkāṭ or Panakkāṭ Nampūtiri) composed his *Praśnamārga* in the Kollam year *marādi* (825=A.D. 1650)[5] and a grand-pupil of his (identified with Nārāyaṇan Iḷayatu of Maccāṭ, 1765-1842) composed the *Jātakādeśaratna*. At the instance of a pupil of his from Sthalipura (Mal. Taḷipparampu), his

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1. On Subrahmaṇya Sastri, see Ul. IV. 292 ; Ul. Sup. II. 122-23 ; Va. IV 607; RNP IV. 481-82.

2. On this author, see Ul. Sup. I. 540 ; Va. I. 444.

3. Ed by K Raghavan Pillai, *TSS*, No. 223, Trivandrum, 1968.

4. *Cf.*, *Praśnāyana* X. 14, *yāta 'rājadhavāḥ' samāḥ* and com. thereon *idānīm, 'rājadhavā'* (4982) *ity akṣarasankhyā, samāḥ kalybdā, atītāḥ* / (Edn., *op. cit.*, p. 176). Kali 4982=A D. 1881.

5. On this, see above, p. 66, § 45.

grand-pupil[1] Puruṣottama, who hailed from Sṛprādeśa (Mal. Tṛprayāer ?) composed the *Parśnāyana*. The work has a succinct commentary included in the edition of the work, which, too, to all appearances, has been composed by the author himself.[2]

80. Rāma Varma Koyittampurān (1853-1910)

Rāma Varmā of the royal house of Grāmam was a scion of the principality of Parappanāṭ which took refuge in Travancore when Tipu Sultan of Mysore invaded Malabar in 1807. He was a versatile scholar and author of several literary works. He studied Jyotiṣa under Prince Ampurājā at the Chirakkal Palace in North Malabar and composed, in that discipline, the *Jyotiṣapradīpa*, an instructive introduction to astronomy.[3]

81. The later phase

Among later scholars who continued the tradition of Jyotiṣa and who, by their expositions and interpretations, helped to sustain and promote astronomical and astrological studies in the land, a mention might be made of four important names: (1) Rāma Vāriyar of Kaikkulangara (1833-97), author of *Sāmudrikaśāstra* and *Gauliśāstra* and commentator of *Horā* and *Praśnamārga*;[4] (2) A. R. Rajaraja Varma Koyittampurān (1853-1918) who wrote two studies entitled, respectively, *Karaṇapariṣkaraṇa* and *Pañcāṅgaśuddhipaddhati*[5] and *Jyotiṣaprakāśana*,[6] being

1. Elsewhere also in this work, Puruṣottama refers to his teacher's teacher as the author of *Jātakādeśaratna*. *Cf.*, *madgurpr-śrīguror vaktrāj Jātakādeśam utthitam* (III. 19) and *Śrīman-madgurunāthasadgurumukhāj jātaḥ sphuṭam Jātakādeśas tena* (VIII. 88). The contraction of *Jātakādeśaratna* to *Jātakādeśa* in the above references is, obviously, due to metrical exigencies.

2. On Puruṣottama, see Ul. Sup. I. 225.

3. On Rāma Varma, see Ul. IV.544-50.

4. On Rāma Vāriyar, see the biography included in P. V. Krishna Variyar, *Maṇmaraññа sāhityakāranmār* (Mal.); Ul. IV. 267-76; Ul Sup. II. 107-16; Va. IV. 587-607.

5. Pub. Trivandrum.

6. Ms. No. [illegible] *Des. cata. of Skt. Mss. in the Curator's Office Library*, vol. V, Trivandrum, 1939, pp. 1489-91.

an exposition of the *Golādhyāya* of Bhāskara II ;[1] (3) Vāsuṇṇi Mūssatu of Veḷḷānaśśeri (1855-1914), author of an erudite commentary in Malayalam on *Pañcabodha* ;[2] and (4) Punnaśśeri Nampi Nīlakaṇṭha Śarmā (1858-1935) who compiled a very instructive manual on astronomy under the title *Jyotiśśāstrasubodhinī* with an extensive elucidation[3] and wrote a *Pañcabodhakriyā-Bhāṣā*, besides commenting, elaborately, on the *Camatkāracintāmaṇi* and the *Praśnamārga*, both published through the Bharata Vilasam Press, Trichur.[4]

82. Modern times

It is significant that, even during modern times, compendiums on astronomy and manuals of computation in Sanskrit continue to be composed by traditional exponents of the discipline.[5] And, what is more interesting is that some of the Western advances, corrections and methods have been duly taken note of and appropriately incorporated in the Sanskrit texts and elucidated in the Malayalam expositions, in these works.[6]

1. On Rājarāja Varma, see Ul. V.791-827 ; Ul. Sup. II. 436-49 ; Va. VI. 27-65.

2. On Vāsuṇṇi Mūssatu, see Ul. IV. 698-703 ; Ul. Sup. II. 373-76.

3. Pub. in 2 parts, Trissivaperur, M.E. 1097, 1104 (A.D. 1922, 1929).

4. On Nīlakaṇṭha Śarmā, see Ul. V. 964-70 ; Ul. Sup. II. 500 ; Va. V. 192-204.

5. See, for instance, *Gaṇitanirṇaya* by P. S. Purushottaman Namputiri, (2nd edn., Quilon, M.E. 1127—A.D 1952) ; *Gaṇitaprakāśikā* by K.V.A. Rama Potuval, (Kannoor, 1950) and *Śuddha-Dṛggaṇitam* by V. P. Kunhikkanna Poduval, (Payyannur, 1956). All these works are in Sanskrit and are provided with Malayalam expositions by their authors themselves.

6. See, for instance, the innovations adopted in the *Gaṇitanirṇaya* of Purushottaman Namputiri, (*op. cit.*), such as fourteen of the Western corrections for the moon, a revision of the traditional astronomical constants in the light of the modern value for the mean motion of the Sun, sine-tables prepared on the basis of the ellipse instead of the circle and revised mnemonics for computations.

CHAPTER VII

GOLADĪPIKĀ OF PARAMEŚVARA

('THE LAMP OF SPHERICAL ASTRONOMY')

Critically edited with

Auto-commentary, Introduction and Translation

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Chapter IV

GOLADIPĪKA ; TRANSLATION AND NOTES

Chapter I

Chapter II

THE GOLADĪPIKĀ BY PARAMEŚVARA

INTRODUCTION

The *Goladīpikā*, presented here in a critical edition for the first time[1] with the author's own commentary, is an important work of Parameśvara who holds an honoured place in the history of Indian astronomy in Kerala.

Contents and Scope of the Work

In this work the author deals, in four chapters containing about 270 verses, with spherical astronomy as envisaged by Indian astronomers and with calculations, measurements, etc., as conceived by Kerala writers on the subject.

The construction of a large Armillary Sphere with two spheres, the inner representing the *Bhagola* (starry sphere), moving inside the other representing the *Khagola* (celestial sphere), and both fitted on the same central axis, forms the subject of the first chapter. Movements of the planets, etc., can be projected and measured on this sphere.

The second chapter is concerned with discussions on the apparent and true motions of the planets, the

[1] The *Goladīpikā* published in the Trivandrum Sanskrit Series No. 49 is a different work. See below.

position of the Moon, the cause of eclipses and the spherical shape of the orbs of the Sun and the Moon.

The next chapter deals with the Earth. The situation of the Earth in the universe, methods of measuring its circumference, our relative sense of directions, and a detailed elucidation of the differences in the length of the days and nights, and the rising of the Zodiacal Signs (*Rāśi-s*) towards the poles, and related phenomena observed in those places, take up the first part of this chapter. In the latter part an account of Purāṇic cosmogony is given.

The fourth chapter is devoted to theories underlying astronomical measurements. The Earth-line (*Bhū-sūtra*) is defined first. The great gnomon and shadow (*Mahā-Śaṅku* and *Mahā-Chāyā*) are then elaborately dealt with. Methods of calculating the great gnomon for different directions are given and illustrated in verses 7-22. The generally used 12-inch gnomon and the calculation of the true position of the Sun therefrom is explained in verses 24-53. Calculation of the Earth's shadow and the angular diameters of the Sun and Moon at the time of eclipses is given in verses 54-56. Verses 62-78 treat of parallaxes of latitude and longitude, which have peculiarities in the method of calculation in Kerala. Determination of the rising of the Signs (*Lagna*) is then considered in verses 79-84. Methods for the actual measurement of the precession of the equinoxes follow in verses 85-90 and the work concludes with the author giving the latitude and longitude of his place and the date of composition of

the work, the *Śaka* year 1365. Parameśvara's ***Goladīpikā*** is thus a good introduction to the Indian system of spherical astronomy, giving a comprehensive idea of the various Indian theories and conceptions on the subject.

Two Goladīpikā-s

There is another ***Goladīpikā*** published in the Trivandrum Sanskrit Series (No. 49) of which several manuscripts are available. It is also by the same Parameśvara as is seen from references in the work itself:

परमादिनोक्तमेवं संक्षेपादीश्वरेण गोलस्य ।
संस्थानं लघुमतये, वक्तव्यं चान्यदस्ति गोलगतम् ॥
युक्तिः प्रदर्शिता प्राङ् मया महाभास्करीयभाष्यस्य ।
सिद्धान्तदीपिकायां विवृतौ, वक्ष्ये तथापि शङ्कादेः ॥

(verses 68-69).

The author, Parameśvara, sometimes mentions his name as Paramādinā Īśvareṇa (Īśvara prefixed by Parama) for metrical convenience (cf. colophonic verse to his *Āryabhaṭīya-vyākhyā*). The Siddhāntadīpikā is a well-known commentary of his on the ***Mahābhāskarīya-bhāṣya*** of Govinda-svāmin.

In the *Goladīpikā* published in the Trivandrum Sanskrit Series, the author covers more or less the same ground as in the work edited here. But some topics like cosmogony are left out; others, like the conception of the *yuga-s* and calculation of the latitudes of planets, are newly introduced, and some common topics, like

the great gnomon and shadow and parallax, are treated in greater detail. In the published *Goladīpikā*, there is no chapter division in the text and also the topics are not so carefully arranged as in the work edited here. About ten verses are common to the two texts.

There is a unique palmleaf manuscript in Malayalam script of the *Goladīpikā* in the India Office Library, London (No. 6297). This contains the text published in the Trivandrum Sanskrit Series, with profuse quotations from other astronomical works interspersed between the lines.

Parameśvara the author

Parameśvara came of the Bhṛgu *gotra* and Āśvalāyana *sūtra* and was a resident of the village of Ālattūr (Sanskritized into Vaṭaśreṇī, called Vaṭaśśēri) in South Malabar. His house was situated on the northern bank of Nilā or Bhāratappuzha river where it joins the sea, a fact which he mentions in several of his works: cf. *Nilābdhyoḥ saṅgamāt saumye sthitena* (colophonic verse to his commentary on the *Sūrya-siddhānta*).[1] He gives the latitude and longitude of the place at the end of the *Goladīpikā* :

समरेखायाः पश्चादष्टादशयोजनान्तरे ग्रामे ।
स्वरकृतपट्टुलिताक्षे . . . . ॥

(IV. 91).

[1] See also the ending verses of *Goladīpikā* and *Mahābhāskarīya-bhāṣya-vyākhyā* and the introductory verse to his commentary on the *Līlāvatī*.

Thus it was eighteen *yojana-s* to the west of the Central (Ujjain) meridian and having a sine latitude 647 (or 10°-51′ north latitude).

Parameśvara's parentage is not known, but he mentions his teacher Rudra in several of his works. That Parameśvara studied also under a Mādhava and a Nārāyaṇa is attested to by his pupil's pupil, Nīlakaṇṭha Somayājin: cf. परमेश्वरस्तु रुद्रपरमेश्वरात्मजनारायणमाधवादिभ्यो गोलविद्भ्यो गणितगोलयुक्तीरपि बाल्य एव सम्यग्गृहीत्वा . . . .

(*Āryabhaṭīya-bhāṣya, Golapāda*, verse 48)

Parameśvara's grandfather was the pupil of a Govinda,[1] author of *Muhūrta-ratna*. This is stated by Parameśvara himself in his commentary on this latter work:

गोविन्दपूज्यपादेन कृपासंसिक्तचेतसा ।
मुहूर्तानामनुग्राह्यैर्मुहूर्तगणिरुद्धृतः ॥
तद्दिनस्तच्छिष्यपौत्रेण किञ्चिद्वित् परमादिना ।
भावो विव्रियते स्वल्पमीश्वरेण यथाश्रुतम् ॥

Parameśvara refers to this Govinda in his *Ācārasaṅgraha* also:

पितुः पितुर्मे गुरवस्तस्मा गोविन्दनामा भुवि विश्रुतोऽभवत् ।
तेनोदितो यो गुरुपङ्क्तितो मां आप्तः स आचार इह प्रदिष्टः ॥

[1] This Govinda is often wrongly identified with Govindasvāmin, commentator of the *Mahābhāskarīya* (cf. Ulloor, *Kerala Sāhitya Caritram*, II 96, 102). Govindasvāmin is an early author who followed on Bhāskara I (seventh century) and is cited by Śaṃkaranārāyaṇa (A.D. 869) in his *Laghubhāskarīyavivaraṇa* and hence is different from this Govinda.

Date of Parameśvara

Parameśvara himself gives the dates of completion of two of his works. He wrote the *Dṛggaṇita* in A. D. 1431; cf.

एवं दृग्गणितं शाके त्रीपुविश्वमिते (1353) कृतम् ।

The present work, *Goladīpikā*, was composed in A. D. 1443; cf.

. . . . शाकेऽक्षषट्त्रिचन्द्र (1365) मिते ।
परमेश्वरनाम्नेयं वदनमुखा गोलदीपिका रचिता ॥

Since Parameśvara says in his *Mahābhāskarīya-bhāṣya-vyākhyā* that he carried on investigations for 55 years before stabilizing his new system and writing his *Dṛggaṇita* in 1431, and since Nīlakaṇṭha Somayājin (born 1443) speaks of being instructed by Parameśvara,[1] our author might be taken to have lived between 1365 and 1460.

Works of Parameśvara

Parameśvara's chief service to astronomy is the revision of the *Parahita*[2] system of astronomy prevalent in Kerala, and the founding of the *Dṛggaṇita* system in order to make the results of astronomical calculations accord with actual observation. Besides presenting eth fundamentals of the new system in a work called *Dṛggaṇita*, he wrote several original treatises on the various aspects of astronomy. These are:

[1] Cf. his *Āryabhaṭīya-bhāṣya*, *Golapāda*, verse 48.

[2] The basic text of this system the *Grahacāra-nibandhana* of Haridatta has been edited by the present editor, Madras, 1954

1. The two *Goladīpikā*-' nd a commentary on one of them.
2. Three works on eclipses—the *Grahaṇa-maṇḍana*,[1] *Grahaṇa-nyāya-dīpikā*,[2] and *Grahaṇāṣṭaka*.[3]
3. *Vākyakaraṇa*,[4] which gives the methods for the derivation of the several astronomical tables used for calculations.
4. *Vyatīpātāṣṭaka-vṛtti*,[5] in verse, on the astronomical phenomena of *Lāta* and *Vaidhṛta*.

He also wrote erudite commentaries on several astronomical texts:

1. *Bhaṭadīpikā* on the *Āryabhaṭīya*.[6]
2. *Pārameśvara* on the *Laghu-bhāskarīya* of Bhāskara I.[7]
3. *Karmadīpikā* on the *Mahā-bhāskarīya* of the same author.[8]
4. *Siddhāntadīpikā* on Govindasvāmin's *Bhāṣya* on the *Mahā-bhāskarīya*.[9]

[1] Mss. Travancore University Manuscripts Library, 788-B, L. 1248-G.

[2] This is a hitherto unknown work of Parameśvara, a much damaged Ms. of which is available in the last folios of Travancore University Ms. 762.

[3] Mss. Travancore University, 475-K, C. 166-E.

[4] A hitherto unknown work of Parameśvara. See Travancore University Ms. C. 133-A.

[5] Travancore University Ms. 788-D.

[6] Ed. H. Kern, Leiden, 1874.

[7] Anandasrama Sanskrit Series No. 128, Poona, 1946.

[8] *Ibid.*, No. 126, Poona, 1945.

[9] Critically edited in the Madras Government Oriental Series by T. S. Kuppanna Sastri.

5. *Pārameśvara* on the *Laghu-mānasa* of Muñjāla.[1]
6. *Vivaraṇa* on the *Sūrya-siddhānta*.[2]
7. *Vivaraṇa* on the *Līlāvatī* of Bhāskara II.[3]

He has also contributed to the astrological aspect of Jyotiṣa through the following works:

1. *Ācārasaṅgraha*.[4]
2. *Jātaka-paddhati*.[5]
3. Commentary on the *Muhūrta-ratna* of Govinda.[6]
4. Commentary on the *Jātaka-paddhati* of Śrīpati.[7]
5. Commentary on the *Praśna-ṣaṭpañcāśikā* of Pṛthuyaśas.[8]

Manuscripts of two other works, *Muhūrtāṣṭaka-dīpikā* and *Bhaṭadīpikā*, which Parameśvara enumerates among his other works at the end of his commentary on the *Mahā-bhāskarīya*,[9] are yet to be discovered. There are also certain other works which are likely to

[1] Anandasrama Sanskrit Series No. 123, Poona, 1944.

[2] Mss. Travancore University No. 8358-J; Madras Oriental Manuscripts Library R. 3730.

[3] Mss. Travancore University 10614-B; Madras R. 338, R. 5160.

[4] Mss. Travancore University 1055-D; Trivandrum Palace Library 867, 868, 869.

[5] Mss. Travancore University C. 1052-B, C. 2478-E.

[6] Mss. Travancore University T. 144.

[7] Mss. Travancore University C. M. 665.

[8] Mss. Travancore University 5963, 12235, T. 612. Madras, D. 13964.

[9] Cf. concluding verse of the commentary

मुहूर्ताष्टकसिद्धान्तवाक्यभाष्यार्थकर्मणाम् ।
दीपिका गोलभटयोश्चकार परमेश्वरः ॥

be Parameśvara's but which lack confirmative evidence of his authorship.

Manuscript Material

The present edition of the *Goladīpikā* is based on seven manuscripts of the text, designated A to G, and two of the commentary, designated A and B, all in palmleaf, written in Malayalam script. The textual manuscripts used are:

A: Ms. No. R. 5192 of the Government Oriental Manuscripts Library, Madras

B, C, D, E, F: Mss. 762-E, 5864-A, 8358-B, L. 1313-B, and T. 341 of the Travancore University Manuscripts Library, Trivandrum.

G: a transcript with Sri G. Harihara Sastri, Madras.

All these manuscripts are complete, except B which lacks four folios in the beginning containing the portion up to II. 36; some lacunae and broken letters occur in E and F.

The manuscripts are not free from obviously corrupt readings, due, probably, to the scribes' ignorance of the subject. A and C, which originally belonged to the same collection show close relationship, even in omissions and corrupt readings (cf. II. 11. 31, 45; IV. 17, 19, 40, etc.), but one is not a copy of the other; for differences see I. 12, 15; II. 23; III. 74, 78; IV. 22, 33. Manuscript F is also akin to these two. Manuscripts D and G have several

common readings, but G, which generally presents a correct text, has been especially useful in determining the text in several places (see, for instance, III. 16, 87; IV. 49), and possesses some unique readings (cf. I. 8; III. 10, 17).

The two manuscripts of the commentary used are:

A. Ms. No. R. 5145 of the Government Oriental Manuscripts Library, Madras.

B. Ms. No. 762-F of the Travancore University Manuscripts Library, Trivandrum.

They are both complete, independent of each other and generally correct. A few emendations have been given in brackets in the edition.

I am extremely thankful to Sri T. S. Kuppanna Sastri, M.A., formerly of the Presidency College, Madras, for his unstinting help and collaboration in the editing and translating of this work. I am indebted to the Travancore University Manuscripts Library and the Government Oriental Manuscripts Library, Madras, and to Sri G. Harihara Sastri for the manuscripts used for this edition. I am grateful to Dr. V. Raghavan for the facilities given to me for doing my research in Kerala works on Indian astronomy and for revising the Introduction.

परमेश्वरकृता गोलदीपिका

प्रथमोऽध्यायः

[मङ्गलाचरणम्]

[1]वन्दे किशोरं पार्वत्या अङ्कसंस्थं गजाननम् ।
स्तन्यपानरतं कल्पद्रुमस्याधो विनायकम्[2] ॥ १ ॥
निलायाः सौम्यतीरेऽब्धेः कूलस्थः **परमेश्वरः** ।
संक्षेपाद् गोलसंस्थानं वक्ति बालाय भार्गवः ॥ २ ॥

[गोलबन्धविधिः]

अधऊर्ध्वयाम्यसौम्यगमिह वृत्तं दक्षिणोत्तराख्यं स्यात् ।
तन्मध्येऽप्यधऊर्ध्वं वृत्तं पूर्वापरं तु घटिकाख्यम् ॥ ३ ॥
बहिरनयोस्तिर्यक् स्याच्चतुराशास्वस्तिकं परं वृत्तम् ।
विषुवत्संज्ञितमेतत् त्रितयं [a]खरसाङ्कमत्र घटिकाख्यम् ॥ ४ ॥

परमेश्वरकृता गोलदीपिकाविवृतिः

अविदितगोलस्थितिभिर्मत्वैषा तु न सुगम्येति ।
गोलस्य दीपिकाया विलिख्यते विवृतिरपि च मूलकृता[3] ॥

३-४. अधऊर्ध्वेति । वंशशलाकादिना निर्मितमिह वृत्तं स्यात् । अधऊर्ध्वदिशोर्याम्यसौम्यदिशोश्च यातं दक्षिणोत्तराख्यं वृत्तं तथा निदध्यादि-

[1] F. *vv.* 1-7, only bits of the lines are available.
[2] D. निवासिनं for विनायकम्.
[3] B. Last *pāda* broken away.

a खरसेति 60.

[a]खरसाग्न्यङ्कमिहान्यद् द्वितयं तद्वत्पुनः परं वृत्तम् ।
पूर्वापरस्वस्तिकगमधऊर्ध्वाभ्यां च सौम्यदक्षिणयोः ॥ ५ ॥
[b]जिनभागे बध्नीयादपमाख्यं दक्षिणोत्तरे वृत्ते ।
घटिकाख्योभयपार्श्वेऽभीष्टकान्यन्तरे ततस्तद्वत् ॥ ६ ॥
स्वाहोरात्राख्यानि च बध्नीयान्मण्डलान्यतुल्यानि ।
अपमगपातद्वयगं[1] सौम्ये याम्ये ततश्च भत्रितये ॥ ७ ॥
परमक्षेपान्तरितं चन्द्रादेः क्षेपमण्डलं भवति[2] ।

त्यर्थः । चतुराशास्वस्तिकं पूर्वदक्षिणपश्चिमसौम्यपार्श्वेषु स्वस्तिकं यथा भवति तथा निदध्यात् । [3]खरसाङ्कं, रेखाणां षष्ट्या अङ्कितं, घटिकामण्डलम् । घटिकाज्ञानार्थमङ्कविधिः ।

५. खरसाग्न्यङ्कितं रेखाणां षष्ट्युत्तरशतत्रयेणाङ्कितमन्यत्[4] मण्डलद्वयम् । त्रिंशांशकपरिज्ञानार्थं तयोरङ्कविधिः । तद्वद् रेखाणां षष्ट्युत्तरशतत्रयेणाङ्कितमन्यदपमण्डलाख्यं वृत्तम् । अधऊर्ध्वाभ्याम् अधऊर्ध्वस्वस्तिकाभ्यामित्यर्थः[5] ।

७a. स्वाहोरात्राणि तद्वत्, घटिकामण्डलवत्, पूर्वापरगाणी[6]त्यर्थः । अतुल्यानि गोलपार्श्वयोः पूर्वापरगत्वात् परस्परमतुल्यानीत्यर्थः । नानाप्रमाणानीत्यर्थः ।

७b-८a. अपमगेति । अपमण्डले यत्र पातस्तिष्ठति तस्मात्सप्तमराशौ द्वितीयः पातस्तिष्ठति । पातद्वयस्थानम् अपमण्डले लग्नम् । ततः पातद्वयस्थानात् त्रिराश्यन्तरे परमक्षेपमानेनापमण्डलादन्तरितं चन्द्रादीनां विक्षेपमण्डलं भवति । प्रथमपातादारभ्य सौम्यगम्, अन्यपातादारभ्य याम्यगं च तत् भवति ।

[1] F. अपक्रमपातद्वयगं. [2] G. क्षेपं च मण्डलं भवति.
[3] B. खरसाङ्कगं. [4] A. न्यम.
[5] B. Two words broken away. Words, here and there are broken away in the next few lines also. [6] Mss. read नी.

[a] खरसाग्नीति 360. [b] जिनेति 24.

विषुवद्वयाम्योदक्स्वस्तिकयोर्गोलदण्डकः[1] प्रोतः ॥ ८ ॥
नक्षत्रगोल एव स्यादिह बाह्ये खगोलोऽस्ति ।
तस्मिन्विषुवत् त्रितयं प्राग्वत्, क्षितिजाख्यमेषु तिर्यक्स्थम् ॥ ९ ॥
सममण्डलं तु पूर्वापरगं, याम्योत्तराख्यमपरं[2] स्यात् ।
कल्प्या भूः समवृत्ता मृदादिना गोलदण्डमध्यगता ॥ १० ॥
गोलस्थितिरेवं स्यात् निरक्षदेशे ह्यभीष्टदेशे तु ।
अध ऊर्ध्वं च खगोले याम्योदक्स्वस्तिकात् पलज्यान्ते ॥ ११ ॥
कृत्वा[3] वेधद्वितयं तत्प्रोतं गोलदण्डकं कुर्यात् ।
उन्मण्डलाख्यवृत्तं गोलगदण्डाग्रयुग्मकप्रोतम् ॥ १२ ॥
कुर्यात्[4] पूर्वापरग[5]स्वस्तिकगं चेष्टदेशगोलोऽयम् ।

८b-९b. विषुवदिति । दक्षिणोत्तरगतं यद्विषुवन्मण्डलं तिर्यग्गतं च यत्ताभ्यामुत्पन्नयोर्याम्योदक्स्वस्तिकयोः प्रोतो गोलदण्डश्च कार्यः । एतच्चक्रं नक्षत्रगोलसंज्ञितं स्यात् । ज्योतिश्चक्रमिति च तदुच्यते । अस्य बहिर्भागे खगोलाख्यं चक्रमपि कार्यम् । तत्रापि[6] विषुवन्मण्डलवत् त्रितयं प्राग्वत् कार्यम् । तेषु घटिकामण्डलवत् पूर्वापरायतं सममण्डलाख्यं स्यात् । तिर्यग्गतं तत्र क्षितिजाख्यं स्यात् । अत्राप्यन्यद्दक्षिणोत्तराख्यं भवति ।

११-१३a. अभीष्टेति । स्वदेशगोलस्थितिसिद्धये खगोलस्य दक्षिणस्वस्तिकादधः उत्तरस्वस्तिकादूर्ध्वं च पलज्याकाष्ठतुल्या तरे दक्षिणशलाकायामुत्तरशलाकायां च वेधौ कृत्वा तयोर्वेधयोर्गोलदण्डस्याग्रद्वयं प्रवेशयेत् । तत्प्रवेशात् प्रागेव गोलयोर्व्यासान्तरालप्रमाणं[7] शरदण्डिकाद्वयं गोलदण्डाग्रयोर्निश्चलं निधेयम् । तदनन्तरं दण्डाग्रयुगं वेधद्वये प्रवेश्यम् । इति कर्मक्रमः ।

[1] G. गोलकः (corrupt.)
[2] A. C. D. मवमं. Here अवम should be taken to mean 'the last'.
[3] A. कृत्वा duplicated.
[4] D. कुर्यात् left out.
[5] D. पूर्वात् परग.
[6] A. omits अपि.
[7] A. व्यासान्तरादल्पप्रमाणं.

शलाकिके च योज्ये दण्डे गोलान्तरे स्थिरत्वाय ॥ १३ ॥
भ्रमति ह्यपराभिमुखं प्रवहाक्षेपात् सदा भगोलोऽयम् ।
स्थिर एव खगोलः[1] स्याद्दिगादिसिद्ध्यै प्रकल्पितो यः[2] ॥ १४ ॥
[3]लम्बाक्षज्ञानार्थं प्रकल्प्यते दण्डनाभिहरिजान्ते ।
अन्यद् द्युवृत्तमक्षैर्ज्याक्षाग्रेह लम्बकः[4] क्रान्तिः ॥ १५ ॥

इति गोलदीपिकायां गोलबन्ध[5]विध्याख्यः[6]
प्रथमोऽध्यायः[7]

पुनः क्षितिजवदपरं वृत्तं पूर्वापरस्वस्तिकयोर्लग्नं गोलमध्यगतदण्डस्याग्रद्वयप्रोतं[8] दक्षिणोत्तरशलाकयोर्लग्नं कुर्यात् । तदुन्मण्डलं भवति । एवं स्वदेशगोलावस्थितिः ।

१३b-१५. शलेति । गोलान्तरे भगोलखगोलयोरन्तरगतगोलदण्डभागे । लम्बेति । बालानां लम्बाक्षयोः स्वरूपप्रदर्शनाय क्षितिजमण्डलावसाने उदग्भागे याम्यभागे वा अक्षज्यातुल्यव्यासार्धमेकं द्युमण्डलं गोलदण्डमध्ये केचित्प्रकल्पयन्ते, यथा तस्याधःपरिधिरूर्ध्वपरिधिर्वा क्षितिजस्पृग् भवति । तत्र[9] द्युवृत्तोन्मण्डलयोः संपातात् पूर्वस्वस्तिकान्तमवलम्बधनुः । क्रान्तिस्थानीयोऽत्रावलम्बकः कोटिरूपः स्यात् । द्युवृत्तस्य व्यासार्धमक्षज्याख्यभुजा । सात्र भुजास्थानीया । द्युवृत्तक्षितिजसंपाताद् भूमध्यान्तं कर्णः । स तु त्रिज्यामितः ।

इति गोलबन्धविधिः प्रथमः

[1] D. भगोल (wrong). [2] G. कः. [3] A. Corrupt लंबोक्ष.
[4] A. C. का. [5] A. C. G. निबन्धन; D. F. बन्धन.
[6] आख्य; not in MSS.; it is added to be uniform with the other chapter colophons. [7] A. B. C. E. omit अध्यायः.
[8] A. स्याधःपात [9] B. तद्.

द्वितीयोऽध्यायः

[दैनंदिनं ग्रहभ्रमणम्]

अपमण्डले तु सूर्यः पूर्वाभिमुखः सदा चरति ।
भ्रमति ह्यपराभिमुखं वेगाधिक्यात्तथापि गोलस्य ॥ १ ॥
प्रवहमरुत्प्रक्षिप्तो भगोल उर्वीं प्रदक्षिणीकृत्य ।
अपराभिमुखं षष्ट्या घटिकाभिर्भ्रमति भूयोऽपि ॥ २ ॥
भूपृष्ठादुपरि मरु[a]द्रवियोजनसंमितान्तरे प्रवहः ।
नियतगतिरपरगः स्याद्, भूवायुरधश्च तस्य भिन्नगतिः ॥ ३ ॥
घटिकाख्यषष्टिभागभ्रमणे[1] कालोऽत्र नाडिकेत्युदिता ।
न तु दिवसषष्टिभागो गोलभ्रमणाद्यतोऽधिको दिवसः ॥ ४ ॥
भूपार्श्वगतं क्षितिजं तदूर्ध्वगास्तूदिता ग्रहा दृश्याः ।
भूमितनुव्यवधानात्तस्याधःस्था ग्रहा न दृश्यन्ते ॥ ५ ॥
इति गदितं शास्त्रेषु क्षितिपृष्ठादूर्ध्वगा ग्रहा ह्येव ।
अस्माभिर्दृश्यन्ते कुपृष्ठतोऽधोगता न दृश्यन्ते ॥ ६ ॥

१-२. अथ गोले ग्रहचारः प्रदर्श्यते—अपमण्डल इति । अत्रापमण्डलस्य पूर्वापरगत्वं प्रकल्प्य तस्मिन् पूर्वाभिमुखश्चरतीत्युक्तम्, न तु साक्षात्पूर्वाशामङ्गीकृत्य[2] । प्रदक्षिणीकृत्य, उर्व्याः परित इत्यर्थः ।

४. घटिकामण्डलस्य षष्टिभागभ्रमणे यः कालः सोऽत्र गोलभ्रमणविषये नाडिकेत्युच्यते । तासां नाडिकानां षष्ट्या गोलो भ्रमति । एकोनषष्टिप्राणहीनैः सावनाहोरात्रासुभिः गोलो भ्रमतीत्यर्थः ।

५-६. क्षितिजं भूपार्श्वगतं स्यात् । भूपार्श्वरेखावत् तत्परितो गत-

[1] G. भ्रमेण. [2] A. leaves out this word.

[a] रविः 12.

अपमगतत्वाद् भानुस्तस्य स्थानानुसारतः सौम्ये ।
याम्ये वा यात्युदयं मध्यदिशस्तद्वदेव चास्तमपि ॥ ७ ॥
चन्द्राद्या विक्षेपादपमादपि सौम्ययाम्यदिक्स्थाः स्युः ।
साक्षे देशे ह्युदयाद्याम्ये यान्ति ग्रहा नभोमध्यम् ॥ ८ ॥
प्रागुन्मण्डलगोऽर्कः[1] त्रिंशद्घटिकाभिरेति पश्चिमगम् ।
[2]उन्मण्डलं, ततोऽपि च तावत्कालेन पूर्वगतम् ॥ ९ ॥
अत्र तु घटिकाशब्दो दिनषष्ट्यंशस्य वाचकः प्रोक्तः ।
व्यवहारो ह्यनयैव स्याद् गोलभ्रमणतोऽन्यत्र ॥ १० ॥
क्षितिजे ह्युदयास्तमयौ सौम्ये तून्मण्डलादधः क्षितिजम्[3] ।
तस्मात्सौम्ये गोले [4]त्रिंशद्घटिकाधिकं दिनं भवति ॥ ११ ॥
याम्ये तूर्ध्वं क्षितिजं त्रिंशद्घटिकात ऊनमत्र दिनम् ।
दिनवृद्धौ तु निशोना निशाधिका तत्क्षये तु सर्वत्र ॥ १२ ॥
त्रिंशद्घटिका दिवसो निरक्षदेशे सदा निशा च तथा[5] ।
उन्मण्डलमेव यतः क्षितिजाख्यं मण्डलं भवेत्तत्र[6] ॥ १३ ॥

मित्यर्थः । तत्स्थे ग्रहे तस्योदय इति शास्त्रे गदितम् । भूपृष्ठरेखासमे सति पूर्वमन्याभिर्दृश्यः स्यात् ।

७. अपमेति । मध्यदिशः पूर्वापरदिश इत्यर्थः ।

९. पूर्वापरयोः उन्मण्डलयोः अन्तराले सूर्यस्य भ्रमणं त्रिंशद्घटिका-भिरित्याह—प्रागिति ।

११. दिनानिशावृद्धिह्रासयोर्हेतुमाह—क्षितिजे [7]हीति ।

[1] D. [illegible] for गोऽर्क.

[2] D. gap up to [illegible]; blank space left. [3] A. C. E. [illegible].

[4] A. C. From here up to त्रिंशद्घटिका below omitted by haplography.

[5] D. G. [illegible] निशा च सदा. [6] G. [illegible]. [7] A. हि omitted.

[अर्काग्रादीनां स्वरूपम्]

क्षितिजे यत्रार्कयुतिस्तस्मात्पूर्वापराख्यसूत्रान्ता ।
जीवार्काग्राऽस्तोदयसूत्रं पूर्वापरं तदग्राच्च ॥ १४ ॥
उन्मण्डलार्कयोगप्रागपरस्वस्तिकान्तरालज्या ।
क्रान्तिज्या, सात्र भुजा, सूर्यस्थितभागगं द्युवृत्तं यत् ॥ १५ ॥
तद्व्यासार्धं द्युदलं कोटिः सा स्यात्, त्रिजीवका कर्णः ।
[1]यस्मिन्वृत्ते सूर्यस्थितभागो भ्रमति[2] तद् द्युवृत्ताख्यम् ॥ १६ ॥
क्षितिजोन्मण्डलविवरे द्युवृत्तजीवाभुजा क्षितिज्याख्या[3] ।
क्रान्तिज्यात्र तु कोटिः स्यादर्काग्रा श्रुति[4]स्त्रिभिस्त्र्यश्रम् ॥ १७ ॥

[ग्रहाणां पारमार्थिकी प्राग्गतिः]

विषुवत्संस्थो भानुर्लङ्कायां नभसि मध्यरेखायाम् ।
भ्रमति ह्यपराभिमुखं निरक्षदेशे तथैव सर्वत्र ॥ १८ ॥
अर्कः स एव मेरौ भ्रमति समन्तात् क्षितेस्तु पार्श्वगतः ।

१४. अर्काग्रास्वरूपमाह—क्षितिजे यत्रेति ।

१५a. क्रान्तिस्वरूपमाह—उन्मण्डलेति ।

१५b-१६a. द्युज्यां तस्याः कोटित्वं च क्रान्तेर्भुजात्वं चाह—सूर्येति । तयोः कोटिभुजयोः कर्णः त्रिज्या स्यात् ।

१६b. द्युमण्डलस्य स्वरूपमाह—यस्मिन्निति ।

१७. क्षितिज्यास्वरूपं तदाश्रितं क्षेत्रं चाह—क्षितिजोन्मण्डलेति । क्षितिज्या भुजा, क्रान्तिः कोटिः, अर्काग्रा कर्णः इति त्र्यश्रं क्षेत्रं प्रतिदेशम् ।

१८-१९. सूर्यस्य भ्रमणभेदमाह—विषुवदिति । अन्यत्र, निरक्ष-

[1] D. G. तस्मिन्.
[2] D. क्रमति.
[3] F. क्षितिजा स्यात्.
[4] F. त्रिभिः left out.

अन्यत्र स्वाक्षवशात् खमध्यभूपार्श्वयोर्भ्रमति मध्ये ॥ १९ ॥
अचलानि भानि तेषामधः क्रमान्मन्दजीवकुजदिनपाः ।
सितबुधशशिनश्चैते गच्छन्तः प्राङ्मुखं स्वगत्या तु ॥ २० ॥
अपराभिमुखं गोलभ्रमणात् सर्वे भ्रमन्ति लङ्कायाम् ।
[1]घटकारकस्य चक्रे विलोमगाः कीटका यथा तद्वत् ॥ २१ ॥
अधउपरिगतखगानां प्रागत्या योजनानि तुल्यानि ।
सर्वेषां दिवसे स्युस्तथापि तेषां कलागतिर्भिन्ना ॥ २२ ॥
कक्ष्याल्पाधःस्थस्य ग्रहस्य, महती तथोर्ध्वगस्य भवेत् ।
स्वल्पायां च[2] महत्यां लिप्ता भामाश्च[3] राशयस्तुल्याः ॥ २३ ॥
पूरयति चाल्पवृत्ते चरन्निजं वृत्तमल्पकालेन ।
महता कालेन चरन् महति दिने गतिकलास्ततो भिन्नाः ॥ २४ ॥

मेरुमध्यामन्यत्र, खमध्यभूपार्श्वयोर्मध्ये खमध्याद्दक्षिणे भूपार्श्वादुपरीत्यर्थः । स्वाक्षवशादक्षतुल्यं खमध्याद्दक्षिणं मानमित्यर्थः ।

२०-२१. भानां स्वतो गतिनिवृत्तिं, तदधः शन्यादीनां कक्ष्याक्रमं चाह—अचलानीति । स्वकर्तृका गतिस्तेषां नास्तीत्यर्थः । गोलभ्रमणादपराभिमुखी गतिरस्त्येव । लङ्कायां लङ्कादिनिरक्षदेशे स्वगत्या प्राङ्मुखं गच्छन्तो गोलभ्रमणादपराभिमुखं भ्रमन्ति ग्रहाः । ततोऽन्यत्र स्वाक्षवशात् तिर्यग्भ्रमणमित्यर्थः ।

२२. अधश्चरतामुपरि चरतां च ग्रहाणां दिने दिने जातानि गतियोजनानि तुल्यानि । तथापि कक्ष्याभेदात् गतिकला प्रतिग्रहं भिन्नेत्याह—अधउपरीति ।

[1] D. G. घटकारस्य तु चक्रे.

[2] A. त्वमहत्यां, may be तु महत्यां ; G. स्वल्पायाश्च महत्या.

[3] A. omits च.

दृश्यन्ते सर्वखगा अपराभिमुखं भ्रमन्त एवेह ।
एवं स्थिते ग्रहाणां पूर्वगतिः कल्प्यते कया युक्त्या ॥ २५ ॥
दस्रयुतः शीतकरो ह्यपरदिने दृश्यते यमर्क्षस्थः[1] ।
भौमादयश्च तद्वत् पूर्वगतिर्निश्चिता ततस्तेषाम् ॥ २६ ॥
मन्दगतिरिन्दुरार्किः शीघ्रगतिस्तारकास्तु शीघ्रतराः ।
गच्छन्त्यपराभिमुखं सर्वेऽप्येवं[2] वदन्ति किल केचित् ॥ २७ ॥
मन्ये तदपि न युक्तं [3]यस्माद्वक्रिग्रहोऽनलर्क्षस्थः ।
तत्पश्चिमगभरण्यां दिनान्तरे दृश्यते न पूर्वदिशि ॥ २८ ॥

[सूर्यापेक्षया शशिनः स्थानम्]

अर्कादुपरि शशी स्यादिति कवयो ये वदन्ति तत्पक्षे ।
नेन्दुरयं प्रत्यक्षस्तत्रान्यच्चान्द्रदैवतं कल्प्यम् ॥ २९ ॥

२५. स्थूलदृष्ट्या ग्रहाणां पश्चिमाभिमुखगतित्वमिच्छन्ति केचित् । तत्पक्षमाह—दृश्यन्त इति ।

२६. तन्निराकरोति—दस्रयुत इति । पूर्वदिनस्थितस्थानादपरदिने पूर्वदिशि दृश्यते चन्द्र इत्यर्थः ।

२७. अन्ये पुनः चन्द्रादीनां क्रमात् शीघ्रगतित्वं, नक्षत्राणां तेभ्योऽप्यतिशीघ्रगतित्वं च परिकल्प्य सर्वेषां पश्चिमाभिमुखगतित्वमिच्छन्तीत्याह—मन्दगतिरिति । अस्मिन् पक्षे दस्रयुतचन्द्रस्यापरदिने भरणीसहितत्वं न दुष्यति ।

२८. एतन्निराकरोति—मन्य इति ।

२९. अर्कादुपरि शशीति वादिनां महतां वचनं प्रमाणीकर्तुमिह दृश्यमानस्य चन्द्रस्य सूर्यादधः स्थितेरनुमानसिद्धत्वात् सूर्यादुपरि किमपि चान्द्रं दैवतमस्तीति कल्प्यमित्याह—अर्कादिति ।

[1] A. C. G. मर्कस्थः (wrong) ; D. मर्क्षस्थे.

[2] G. सर्वे चैवं.

[3] F. कस्माद्वक्री ; G. यस्माद्वक्री.

भानि खगानामूर्ध्वं, तेषां मुनयस्तथोर्ध्वगाः सप्त ।
उपरि ध्रुवश्च तेषामिति च प्रोक्तं पुराणविद्भिस्तैः ॥ ३० ॥
मेरावेव ह्येवं भवति ततो मेरुगाः पुराणविदः ।
मेरौ तु यमान्तेऽर्के सौम्यक्षेपो विधुस्तदाऽऽसन्नः[1] ॥ ३१ ॥
[2]उपरिगत एव सूर्याद्दृश्यते तत्स्थितैस्तदा वा स्यात् ।
अर्कोऽमावास्यान्ते चन्द्रमसा क्षेपहीनेन ॥ ३२ ॥
संछाद्यते च, तस्मात् निश्चितमर्काच्छशी ह्यधःस्थ इति ।
यद्यर्कादुपरि विधुस्तथा ह्यधःस्थार्कबिम्बच्छादनाभावात् ॥ ३३ ॥
ह्रसेत पूर्णतरः[3] कृष्णे पक्षे यथोदयवान् ।

[शशिनः शौक्ल्यम्]

शौक्ल्यं स्वाभाविकमिति मन्यन्ते ये पुनस्तु चन्द्रमसः ॥ ३४ ॥

३०-३१a. अथवा तैरपि पौराणिकैरपार्थेव [illegible] विषयभेदात् सूर्यादुपरीति कल्पित इत्याह—भानीति । ग्रहाणामुपरि नक्षत्राणि, तेषामुपरि सप्तर्षयः, तेषां चोपरि ध्रुव इति हि वदन्ति पुराणविदः । द्रष्टरि मेरुसंस्थिते तत्त्वैव तथा संभवति । अतः पुराणविदो द्रष्टारं मेरुसंस्थितं प्रकल्प्य सूर्यादुपरि चन्द्र इति वदन्ति । मेरुस्थितो हि द्रष्टा यमान्तगतादल्पोन्नतार्कात् यमान्तसमीपगतमुदग्विक्षिप्तं चन्द्रमुपर्येव पश्यति । ततः कारणाद्वा तेषां पुराणविदां सूर्यादुपरि चन्द्र इति स्मृतिः स्यात् ।

३२b. सूर्यादधःस्थश्चन्द्र इत्यस्मिन् पक्षे युक्तिमाह—अर्कोऽमेति ।

३३b. अर्कादुपरि चन्द्र इति पक्षेऽनुपपत्तिं प्रदर्शयति—यद्यर्कादिति ।

३४b. चन्द्रस्य शौक्ल्यं स्वाभाविकमेव, न स्वर्ककरैर्जातम् । अतः कृष्णपक्षे क्षयोदयावपि यथादर्शनं युक्तमेवेति चेत् तदप्ययुक्तमित्याह—शौक्ल्यमिति ।

[1] A. C. corrupt विधुन्तुदासन्नः .

[2] F. ac. 32-34 only bits of the lines available.

[3] G. ष्ट.

शौक्ल्यस्य क्षयवृद्ध्योरपि हेतुस्तैश्च[1] वक्तव्यः ।
अर्काधःस्थस्येन्दोरूर्ध्वार्धे ह्यर्करश्मयोऽमान्ते ॥ ३५ ॥
दृश्यार्धमतः कृष्णं तदार्कतः पूर्वगे तु चन्द्रमसि ।
पश्चिमपार्श्वेऽर्ककरा लम्ब्यन्ते तत्र शौक्ल्यमत इन्दोः ॥ ३६ ॥
एवं क्रमवृद्धिः स्याच्छौक्ल्यस्य हि[2] पूर्णता च पूर्णान्ते ।
पश्चिमभागे कार्ष्ण्यं ततः क्रमात् सूर्यरश्मिराहित्यात् ॥ ३७ ॥

[ग्रहणस्वरूपम्—पूर्वपक्षः]

ग्रसति यदि राहुरर्कं चन्द्रं वा राहुसम[3]भक्षस्थौ ।
चन्द्रार्कौ दूरगतौ ग्रस्येते दूरगेण कथमहिना ॥ ३८ ॥
चक्रार्धान्तरितौ द्वौ[4] राहू इति चेत्तदापि[5] कथमिन्दोः ।
स्पर्शः प्राग्भागे स्यान्मोक्षः पश्चात्ततोऽन्यथा च रवेः ॥ ३९ ॥

३५b. सूर्यादधःस्थश्चन्द्र इति पक्षे शौक्ल्यस्य क्षयवृद्धी संभवत इत्याह—अर्काधःस्थस्येति। अर्कग्रहणे शशिनश्छादकत्वाच्चन्द्रस्याधःस्थितिरिह कल्पिता ।

३८-३९. अर्को राहुणा छाद्यते इति ये वदन्ति तत्पक्षे दूषणमाह—ग्रसति यदीति । इन्दोः प्राग्भागे नियमेन स्पर्शो दृश्यते । मोक्षस्तु पश्चाद्भागे । इतोऽन्यथा रवेः स्पर्शमोक्षौ नियमेन दृश्येते । चन्द्रार्कयोः राहुः छादकश्चेत् कथं तथा संभवति?

[1] D. G. तु for च. [2] G. च for हि.

[3] Ms. B. commences only from here. Four folios containing the previous portion are lost in the Ms.

[4] G. तोधौ (corrupt). [5] G. तथापि.

राहोर्वदनगतश्चेत्तीक्ष्णविषाणः कथं रविर्भवति ।
तत्र गतः शीतांशुः कुण्ठविषाणश्च दृश्यते कस्मात् ॥ ४० ॥

[सिद्धान्तः]

छादक इन्दुर्भानोः शशिनो महती च भूच्छाया ।
अर्कात् सप्तमराशौ भूच्छाया वर्ततेऽर्क[1]समभुक्तिः ॥ ४१ ॥
छाद्यस्य शीघ्रगत्वात् प्राक् स्पर्शः, पश्चिमे विधोर्मोक्षः ।
छाद्यस्याल्पगतित्वाद् विपरीतं तद्द्वयं रवेर्भवति ॥ ४२ ॥
छादकवृत्तं भानोः स्वल्पमतस्तीक्ष्णशृङ्गता भवति ।
छादकवृत्तं शशिनो महदेवातोऽस्य कुण्ठशृङ्गत्वम् ॥ ४३ ॥
गणितानवगम्यं यद् ग्रहणं[2] तूत्पातरूपमाद्योक्तम् ।
तत्कारणवाची वा स्वर्भानुर्वेदनिर्दिष्टः ॥ ४४ ॥
सतमस्कं पर्व[3] विना त्वष्टा नामार्कमण्डलं कुरुते ।
स निहन्ति सप्त नृपतीनित्यादि हि वचनमस्ति पूर्वेषाम् ॥ ४५ ॥

४०. दूषणान्तरमाह—राहोरिति । अर्धाधिके ग्रस्ते रवौ तीक्ष्णविषाणो रविर्दृश्यते । दृश्यभागे बालचन्द्रवत् तीक्ष्णाग्रविषाणद्वययुत इत्यर्थः । अर्धाधिके ग्रस्ते चन्द्रे कुण्ठविषाणो दृश्यते विधुः । अष्टमीचन्द्रवत् विषाणरहितो दृश्यभाग इत्यर्थः । तच्च कथं भवति ?

४१a. स्वपक्षे छादकं प्रदर्शयति—छादक इति ।

४१b. भूच्छायायाः स्थानं गतिं चाह—अर्कादिति ।

४२. स्वपक्षे स्पर्शमोक्षयोः स्थाननियमे हेतुमाह—छाद्यस्येति ।

४३. तीक्ष्णविषाणादौ हेतुमाह—छादकवृत्तमिति ।

४४. विषयभेदेन राहोश्छादकत्वमनुवदति—गणितानवगम्यं यदिति

[1] A. C. E. वर्तते हि. [2] B. ग्रहं. [3] E. कल्प for पर्व.

[ग्रहाणां गोलाकारत्वम्]

गोलाकारं मण्डलमर्कादीनां स्मृतं गणकमुख्यैः ।
[1]दर्पणवृत्ताकारं दूरगतत्वात् प्रदृश्यतेऽस्माभिः ॥ ४६ ॥
शशिबिम्बे दर्पणवद् वृत्ते तस्यैकदेशसितलब्धिः ।
भानोः करसंपाते [2]व्यवधानाभावतो न संभवति ॥ ४७ ॥
[a]दिग्वेदजलधियोजनतुल्यं सूर्यस्य तैजसं बिम्बम् ।
तस्य च योजनकर्णः [b]शरवसुबाणाङ्कबाणजलधिमितः[3] ॥ ४८ ॥
[c]पञ्चैकवह्नियोजनतुलितं[4] चन्द्रस्य बिम्बमाप्यं तत् ।
योजनकर्णस्तस्य [d]स्वरनगरामाब्धिरामतुलितः स्यात् ॥ ४९ ॥
सलिलमये शशिनि रवेर्दीधितयो मूर्च्छितास्तमो नैशम् ।

४६. अर्कादीनां मण्डलस्य गोलाकारत्वमाह—गोलाकारमिति ।

४७. दर्पणवद् वृत्तमिति पक्षे दूषणमाह—शशिबिम्ब इति ।

४८. सूर्यस्य बिम्बस्य व्यासयोजनं तत्स्वरूपं च सूर्यस्य योजनकर्णमानं चाह—दिग्वेदेति ।

४९. चन्द्रस्याप्याह—पञ्चैकेति ।

५०. अर्करश्मिसंपातेन चन्द्रबिम्बशौक्ल्यं स्यादिति दृष्टान्तसहितमाह—सलिलेति ।

इति ग्रहचारविधिर्द्वितीयः

[1] F. Up to verse 50, only bits of the lines available.
[2] A. C. E. व्यवधानादतो.
[3] B. G. मितम्.
[4] F. G. तुलितः.

a दिग्वेदेति 4410.
b शरेत्यादि 459585.
c पञ्चैकेति 315.
d स्वरेत्यादि 34377.

क्षपयन्ति मन्दिरगतं यथा तमो दर्पणोदरे पतिताः[1] ॥ ५० ॥

इति गोलदीपिकायां ग्रहचारनिरूपणाख्यो[2]
द्वितीयोऽध्यायः[3]

तृतीयोऽध्यायः

[स्वाधारा भूः]

[4]समवृत्तो भूगोलः [a]शून्येषुखचन्द्रयोजनव्यासः ।
तिष्ठति मध्ये व्योम्नो निजशक्त्या धारणात्मिकया ॥ १ ॥
अन्यैर्न दह्यतेऽग्निः स्वयं तु सर्वाणि दहति वस्तूनि ।
एवं धरापि नान्यैर्धार्या निखिलं स्वयं तु धारयति ॥ २ ॥
भूमिरनन्तेन धृतेत्येकेऽन्ये दिग्गजैरिति ब्रुवते ।
आधारस्य च कल्प्योऽत्राधारोऽतोऽनवस्थितिस्तेषाम् ॥ ३ ॥

[भूचलननिराकरणम्]

एकाह्नेन भ्रमति क्षोणी प्रागभिमुखीति चान्यमतम् ।

१. भूमेः स्वरूपमानाद्याह—समवृत्त इति ।
२. भूमेर्धारणात्मिकां शक्तिं दृष्टान्तद्वारेणाह—अन्यैरिति ।
३ भूमेराधारकल्पनायां दूषणमाह—भूमिरिति ।
४. भूमेर्भ्रमणपक्षे दूषणमाह[5]—एकाह्नेनेति ।

[1] A. D. E. G. पतितम् ; F. पतिताम् (corrupt).
[2] B. निरूपणं ; D. G. निरूपणाख्यो omitted; E. निरूपणो.
[3] A-F. अध्यायः omitted. [4] G. वृत्तो भूगोलाख्यः. [5] आहुः.

[a] शून्येत्यादि 1050.

कथमत्रागच्छेयुर्नीडं नीडाद्[1]बहिर्गता विहगाः ॥ ४ ॥
आकाशस्यानन्त्यात् सदाप्यधो गच्छतीति भूरन्ये ।
वियति क्षिप्ता लोष्टाः कथं पतेयुस्तदा भूमौ ॥ ५ ॥

[भूमानम]

मानं भूपरिधेः [a]स्यान्नवनवदस्राग्नियोजनैस्तुलितम् ।
त्रैराशिकानुमानाद् गणकाचार्यैः प्रकल्पितमिदं स्यात् ॥ ६ ॥
आर्यभटेन यदुक्तं भूकर्णादेः प्रमाणमन्यैस्तत् ।
अर्धाधिकं तु पठितं योजनमानस्य [2]भेदक्लृप्त्या तत् ॥ ७ ॥

[स्वाक्षांशाः ध्रुवश्च]

लङ्कायां क्षितिजस्थो ध्रुव उपरि खमध्यगः स मेरौ स्यात् ।
लङ्कायां [3]विषुवस्थो दिनमध्ये व्योममध्यगः सूर्यः ॥ ८ ॥
भानुः स एव मेरुस्थाने तु क्षितिजसंस्थितो भवति ।
लङ्कात उदग्गमनाद् ध्रुवोन्नती रविनतिश्च कल्प्यातः ॥ ९ ॥

५. भूमेरधोगमनपक्षे दूषणमाह—आकाशस्येति ।

६. भूपरिधेर्मानमाह—मानमिति ।

७. गणिततन्त्रभेदेषु दृश्यमानो भूमानकर्णमानादेर्भेदो योजनमानक्लृप्त्येत्याह—आर्यभटेनेति ।

८-११. लङ्कात उदग्गमनवशाद् ध्रुवस्योन्नतिर्विषुवद्दिनमध्याह्नार्कस्य अवनतिश्च भवत इत्याह—लङ्कायामिति । भानुः स एव लङ्कायां विषुवद्दिन-

[1] Mss. read नीळं नीळात्, ळ for ड being a provincial peculiarity.
[2] A. C. D. भेदतत्क्लृप्त्या. [3] B. विषुवत्स्थो.

a नवेबाद्रि 3299.

साक्रावनतिर्देशे [1]स्वेऽक्षज्या स्याद् ध्रुवोन्नतिर्वापि ।
अक्षज्यार्कावनतिध्रुवोन्नतीनां क्रमादुदग्वृद्धिः ॥ १० ॥
अक्षज्यावृद्धिवशादुत्तरगमनं ततस्तु लङ्कातः ।
[2]ज्ञेयं तथा स्वदेशादक्षाधिक्येन सौम्यगमनमपि ॥ ११ ॥

[भूपरिध्यानयनम्]

समयाम्योदक्संस्थौ देशौ ज्ञात्वा [3]तयोः पलज्ये च ।
योजनसंख्यां च तयोर्मध्ये त्रैराशिकं ततः कार्यम् ॥ १२ ॥
अक्षद्वयान्तरांशैर्देशद्वयमध्ययोजनानि यदि ।
लभ्यन्ते चक्रांशैः कानीति स्याद् भुवः परिधिमानम् ॥ १३ ॥
अथवाक्षद्वयविवरजभागैस्तन्मध्ययोजनानि यदि ।
त्रिभसममेरुपलांशैस्तदा कियन्तीति भूपरिधिपादः ॥ १४ ॥

मध्याह्नकाले भानुरित्यर्थः । सा अर्कावनतिः, विषुवद्दिनमध्याह्नकाले स्वीये देशे अर्कावनतिः स्वदेशाक्षज्या स्यात् । ध्रुवोन्नतिर्वापि स्वदेशध्रुवोन्नतिर्वाक्षज्या भवति । अक्षादीनामुदग्देशे क्रमाद् वृद्धिः स्यात् । स्वदेशाक्षस्य वृद्धिवशात् लङ्कातः स्वदेशस्योदग्गमनं वेद्यम् । तद्धानिवशात् दक्षिणगमनं च ।

१२. समयाम्योदग्गतयोर्द्वयोर्देशयोरक्षचापान्तरेण तयोरन्तरालगतयोजनैश्च भूपरिधिमानं त्रैराशिकात्कल्प्यमित्याह — समेति ।

१३. त्रैराशिकप्रकारमाह — अक्षद्वयेति ।

१४. भूपरिधिपादमानानयने त्रैराशिकमाह — अथवेति । त्रिभसममेरुपलांशाः त्रिराशिसमैः मेरुस्थानपलांशैः लङ्कामेर्वोः पलान्तरांशैरित्यर्थः ।

[1] A. C. E. स्वाक्षज्या.
[2] D. G. ज्ञेयः.
[3] G. वृपरिवृद्धिः.
[4] F. तयोः omitted.

बहुलक्षयोजनमितेत्येके बहुकोटियोजनमितेति ।
अपरे भूमिस्तस्मात्कल्प्यः स्याद्विषयभेदोऽत्र ॥ १५ ॥
योजनमितैश्चतुर्भिर्भूपृष्ठेऽश्रैः[1] कृतानि खण्डानि ।
बहुलक्षमितानि स्युस्तस्मात्तद्वादिनां तु तद्विषयम् ॥ १६ ॥
दैर्घ्योच्छ्रितिविस्तृतिभिर्भूखण्डान्यपि च योजनमितानि ।
[2]बहुकोटिमितानि स्युस्तस्मात्तद्वादिनां [3]तु तद्विषयम् ॥ १७ ॥
प्राणिनिवासो ह्यन्तर्भूमेः सर्वत्र भवति पाताले ।
तद्वद् भूपृष्ठेऽपि च तद्वयमानोक्तिरपि च युक्तातः ॥ १८ ॥

[भूगोलवर्णनम्]

[4]सप्तद्वीपसमुद्राः पूर्वाद् द्विगुणाः [5]क्रमादिति यदुक्तम् ।
तच्चोपासनविषयं गणकैरिति कल्प्यते न दृष्टिसमम् ॥ १९ ॥

१५. बहुलक्षयोजनमिता भूमिरित्येके वदन्ति । बहुकोटियोजनमितेत्यपरे वदन्ति । तेषां वचनं प्रमाणीकर्तुं विषयभेदोऽत्र कल्प्य इत्याह—बहुलक्षेति ।

१६-१७. विषयभेदप्रकारमाह—योजनमितैरिति । भूपृष्ठमेकत्र विषयम् । भूमेरन्तर्भागोऽन्यत्रेत्यर्थः ।

१८. भूपृष्ठभूम्यन्तर्भागयोः प्राणिनिवसनसद्भावात् उभयोर्मानकथनं युक्तमित्याह—प्राणीति ।

१९. सप्तद्वीपानां सप्तसमुद्राणां च मानं क्रमाद् द्विगुणितं भवतीति यत्पौराणिकवचनं तदुपासनविषयमेव । न तु युक्तिसिद्धमित्याह—सप्तद्वीपेति । तथा प्रतिपत्त्या अदृष्टं फलं भवतीत्यर्थः ।

[1] A. C. D. E. F. पृष्ठे तैः.
[2] F. Two lines omitted.
[3] B. G. च for तु.
[4] F. Verses 19-26, only bits of the lines available.
[5] D. G. क्रमादिह.

स्थलबहुलमुपरिगार्धं जलबहुलमधोगतं क्षितेरर्धम् ।
तस्मिन्नधोगतार्धे द्वीपाः सर्वे तथाऽब्धयः कथिताः ॥ २० ॥
जलबाहुल्याज्जलमिति निगद्यतेऽधोगतं क्षितेरर्धम् ।
स्थलमिति चोर्ध्वगतार्धं स्थलबाहुल्यान्निगद्यते तद्वत् ॥ २१ ॥
स्वर्मेरू स्थलमध्ये नरको बडवामुखश्च जलमध्ये ।
त्रिदशा अपि दैतेयाः स्थिता हि तद्वत्तयोः क्रमशः ॥ २२ ॥
मेरोरग्रयुगं स्यात् स्थलमध्यादूर्ध्वगं तयोरेकम् ।
जलमध्याच्चाधःस्थं शिष्टं देवासुरैः क्रमात् सेव्यम् ॥ २३ ॥
अङ्गीकृत्यात्रोक्तं स्थलमध्यं ह्यूर्ध्वमप्यधश्चापि ।

[दिक्कल्पनम्]

आशा हि कल्पिताः स्युर्देशे देशे ततश्च ता भिन्नाः ॥ २४ ॥
यत्रोदयो रवेः स्याद् दिक् पूर्वा तत्र तद्वशाच्चान्याः ।
¹स्वाश्रितभूमिरधः स्यात्सर्वेषां भवति तद्वशाच्चोर्ध्वम् ॥ २५ ॥

[ध्रुवतारे]

मेरोरूर्ध्वगताग्रादूर्ध्वस्था तारका ध्रुवाख्यैका ।

२०. भूमेः स्वरूपमाह—स्थलबहुलमिति ।

२१. जलस्थलविभागकल्पनायां हेतुमाह— जलबाहुल्यादिति ।

२२. स्वर्गनरकयोर्मेरुवडवामुखयोः त्रिदशदैतेयवर्गयोश्च स्थानमाह—स्वर्मेरू इति ।

२३. स्थलजलभागयोरुभयोरपि विनिर्गतौ मेरुरित्याह —मेरोरिति ।

२४. स्थलमध्यमङ्गीकृत्यात्रोर्ध्वाधोविभागकथनं कृतमित्याह —अङ्गीकृत्येति ।

२५. पूर्वादिदिग्विभागमधऊर्ध्वविभागं चाह—यत्रोदय इति ।

¹ A.B.C. था.

मेरोरधोगताग्रादधः स्थितान्या ध्रुवाख्यतारा स्यात् ॥ २६ ॥
ध्रुवयुग्ममिदं गोलस्याश्रयदण्डाग्रयुग्ममिव मेरौ ।
रशनावदतः [परितो[1]] लङ्कायां तूर्ध्वगो भ्रमति गोलः[2] ॥ २७ ॥

[लङ्कादिनगर्यः]

लङ्का च रोमकाख्या सिद्धपुरीसंज्ञिता च यवकोटिः ।
याम्यापरसौम्यप्राग्दिक्षु नगर्योऽभिगा इमा मेरोः ॥ २८ ॥
तासु निरक्षाख्यासु ध्रुवोन्नतिर्नास्त्यतो न पलभा च ।
लङ्कामाश्रित्योक्ता दिश इह याम्यादयो मेरोः ॥ २९ ॥

[मेरोरुच्छ्रितिः]

मेरोरुच्छ्रितिरुक्ता चतुरशीतिसहस्रयोजनमितेति ।
कैश्चित्तन्नाभिमतं गणकानामुच्यतेऽत्र हेतुश्च ॥ ३० ॥

२६b. विषुवत्स्थार्कस्योदयोऽत्राङ्गीकृतः। मेरोरूर्ध्वाग्रादूर्ध्वमधोऽग्रादधश्च ध्रुवतारे भवत इत्याह—मेरोरिति ।

२७. इदं ध्रुवयुग्मं गोलभ्रमणे गोलदण्डाग्रगतमिव भवतीत्याह—ध्रुवयुग्ममिति । ध्रुवयुग्मं दण्डाग्रं कृत्वा गोलो भ्रमतीत्यर्थः । अतो मेरुस्थाने रशनावत् परितो भ्रमति गोलः, लङ्कायामूर्ध्वगो भ्रमति, अधऊर्ध्वयोः पूर्वापरयोश्च गतः सन् भ्रमतीत्यर्थः ।

२८-२९. मेरोश्चतुर्दिक्षु निरक्षदेशगताः समुद्रगाश्चतस्रो नगर्यः सन्तीत्याह—लङ्का चेति । मेरोर्याम्यादयो दिशो लङ्कामाश्रित्य इहोक्ताः, लङ्कागतानां यथा प्रतीतिस्तथोक्ता इत्यर्थः ।

३०-३२. कैश्चिन्मेरुरत्युच्छ्रित इत्युक्तम् । तदनुपपन्नमिति युक्त्या

[1] All Mss. read वदतो ; परितो is reconstructed from the commentary.
[2] F. भूगोलः (corrupt).

यत्र तु नोन्नतिः स्याद्यस्मिन्देशे ध्रुवस्य तूत्तरतः ।
ताराः प्राग्गामिन्यो दृश्यन्ते कतिचिदस्माभिः ॥ ३१ ॥
अत्युन्नते तु मेरौ तदुच्चव्यवधानेन ता न दृश्येरन् ।
अत्युच्छ्रितो न मेरुस्तस्मादिति कल्प्यते तथा चोक्तम् ॥ ३२ ॥
"यत्र तोयनिधिमेखलातले नास्तमेति मिथुनान्तसंस्थितः ।
तप्तहाटकनिभो दिवाकरस्तत्र भोऽक्षपरिमाणमुच्यताम्[1] " ॥ ३३ ॥
इति कनकसदृशतोक्त्या क्षितिजस्पृक्चात्र[2] भानुरिति चोक्तम् ।
अक्षज्यास्मिन् प्रश्ने "कुवेदशशिरामतुलिताः ॥ ३४ ॥
अत्युच्छ्रिते तु मेरावेवं सूर्यो न संभवति ।
उपपत्त्या हीनोक्तिर्विदुषां सर्वाप्युपासनार्था स्यात् ॥ ३५ ॥

प्रदर्शयति--यत्रेति । यस्मिन्देशे ध्रुवोन्नतिर्न्भवते तत्र ध्रुवस्योत्तरगताः ताराः प्राग्गामिन्योऽस्माभिर्दृश्यन्ते । मेरुरत्युन्नतश्चेत् तदुच्चव्यवधानेन ता न दृश्येरन् ।

३३. तत्र पूर्वाचार्यवचनमस्तीति तत्प्रदर्शयति—यत्रेति ।

३४-३५. अत्युच्छ्रितमेरौ दिवाकरस्यास्तमयः संभवत्येवेत्यर्थः । अर्कस्य कनकसादृश्यं क्षितिजस्पर्शे हि भवति । अतस्तप्तहाटकनिभ इत्युक्त्या तस्य क्षितिजाश्रितता चोक्ता । अतोऽस्मिन् प्रश्ने पञ्चदश घटिकाः चरदलं भवति । "कुवेदशशिरामतुलितायामक्षज्यायां हि तावत्प्रमाणं चरदलं भवति । नास्तमेतीत्यनेन चार्धास्तमयं नातिक्रामतीत्युक्तं भवति । अतोऽत्राक्षज्या "कुवेदशशिरामतुलिता स्यात् । विदुषामप्युपपत्त्या हीनोक्ति-रुपासनार्था स्यात् । उपासनार्थेति कल्प्येत्यर्थः ; तथा कल्पिते अदृष्ट-विशेषो भवतीत्यर्थः ।

[1] This is a quotation from Govindasvāmin's Bhāṣya on the *Mahābhāskarīya* III. 25 (Ed. Madras, p. 167).

[2] F. स्वाव may be स्वत.

[ऊर्ध्वाधरभागस्य आपेक्षिकत्वम्]

सर्वत्र भूमिभागे निवसन्ति प्राणिनो द्रुमाश्चापः ।
यद्वत्कदम्बपुष्पग्रन्थिः प्रचितः समन्ततः कुसुमैः[1] ॥ ३६ ॥
भूमेर्यो यो भागः प्रदृश्यते तत्र तत्र स स एव ।
भूमेरूर्ध्वो भागः, सर्वत्र प्राणिनां निवासोऽतः[2] ॥ ३७ ॥
वयमूर्ध्वगता दितिजा अधोगता इति वदन्ति देवगणाः ।
असुरा वयमूर्ध्वगता वदन्ति, देवा [3]अधोगता इति च ॥ ३८ ॥
याम्योदक्स्थास्तद्वत्पूर्वापरसंस्थिता[4]स्तथैव मिथः ।
भूमेरुपरि गताः स्मो वयमिति बुद्धिर्यतोऽस्ति सर्वेषाम् ॥ ३९ ॥

[रविः]

सर्वस्मिन्नपि काले भानोरुदयोऽस्ति देशभेदेषु ।
अस्तमयश्च तथा स्यात् तद्वद्दिनरात्रिभागाश्च[5] ॥ ४० ॥

३६. भूमौ सर्वत्र प्राणिनो द्रुमा आपश्च भवन्तीत्याह—**सर्वत्रेति** । तत्र दृष्टान्तमाह—**यद्वदिति** ।

३७. अत्रोपपत्तिमाह—**भूमेर्यो यो भाग इति** ।

३८-३९. प्रतिदेशमूर्ध्वाधोभागः संभवतीत्याह—**वयमिति** । याम्यदिक्स्था लङ्कावासिनः, उत्तरदिक्स्थाः सिद्धपुरवासिनः, पूर्वदिक्स्था यवकोटिवासिनः, पश्चिमदिक्स्था रोमकवासिनः । लङ्कामधिकृत्यात्र दिगुक्तिः ।

४०. सर्वस्मिन्नपि काले रवेरुदयास्तमयादि देशभेदेषु भवतीत्याह—**सर्वस्मिन्नपीति** ।

[1] This line is a quotation from the *Āryabhaṭīya*, Golapāda, 7.
[2] F. ब्रतः for अतः.
[3] D. G. देवास्त्वधो.
[4] D. संश्रिता.
[5] A. C. भागश्च.

"[1]उदयो यो लङ्कायां सोऽस्तमयः सवितुरेव सिद्धपुरे ।
मध्याह्नो यवकोट्यां रोमकविषयेऽर्धरात्रं स्यात्" ॥ ४१ ॥
मध्येऽशूनामधिकं ह्यौष्ण्यं दृष्टिभ्रमश्च करपातात् ।
एकोऽर्को बहुधातो वर्णेनौष्ण्याच्च[2] देशभेदेषु ॥ ४२ ॥

[ध्रुवप्रदेशे दिनरात्री]

मेषादिराशिषट्क[3]क्षितिजादूर्ध्वस्थितिः[4] सुराणां स्यात् ।
मेषादिमास[5]षट्कं दिनं ततो भवति देवानाम् ॥ ४३ ॥
जूकादिराशिषट्कं देवानां स्यादधोगतं क्षितिजात् ।
जूकादिमासषट्कं निशा ततो भवति देवानाम् ॥ ४४ ॥
दिनरात्री देवानां रात्रिदिने[6] स्तः क्रमेण दितिजानाम् ।
अधउपरि[7]विभागौ स्तो देवासुरभागयोर्यतो व्यस्तम् ॥ ४५ ॥
सर्वस्मादपि देशान्मेर्वेऽर्ध्वी सौम्ययाम्यगौ भवतः ।
[8]विषुवस्थार्कोदयगा पूर्वा दिक् तद्वशात्ततोऽन्याश्च[9] ॥ ४६ ॥

४१. तत्र पूर्वाचार्यवचनमुदाहरणत्वेन प्रदर्शयति—**उदयो य इति** ।

४२. कालभेदेन रवेरौष्ण्यभेदे च हेतुं प्रदर्शयति—**मध्येऽशूनामिति** । उदये ह्यर्कस्यांशुमण्डलं भूगोलस्य पूर्वार्धेऽवतिष्ठते । मध्याह्ने भूमेरुपरि । अस्तमये भूमेः पश्चिमार्धे ।

४३-४५. देवासुराणां दिनरात्रिविभागं सहेतुकमाह—**मेषादीति** ।

४६. सर्वस्मादपि देशान्मेरुरुत्तरदिक्स्थः, समुद्रो दक्षिणदिक्स्थ

[1] *Āryabhaṭīya*, Golapāda, 13.
[2] A. C. F. वर्णौष्ण्याच्च.
[3] F. G. षट्कं.
[4] E. G. स्थितं.
[5] D. G. राशि for मास (corrupt).
[6] G. निशे (corrupt).
[7] A. C. वा.
[8] A. C. F. विषुवस्थो; B. विषुवत्स्थो.
[9] A.B.C.D.E. G. यतोऽन्याश्च.

सौम्ये निरक्षदेशात् सौम्यस्थेऽर्के, दिनं भवेदधिकम् ।
याम्यस्थेऽर्के न्यूनं दिनं निशा व्यस्तमेव सर्वत्र ॥ ४७ ॥
यस्मिन् देशेऽक्षज्या [a]शशिकृतशशिरामसंमिता तत्र ।
षष्टिर्नाड्यो दिवसः शून्या रात्रिर्यमान्तगेऽर्के स्यात् ॥ ४८ ॥
तत्र दिनान्तरयोगात्[1] प्रायेण स्याद्दिनं [b]खरविनाड्यः ।
चापान्तगे तु भानौ षष्टिर्नाड्यो निशा दिनं शून्यम् ॥ ४९ ॥
राशिद्वयापमसमा लम्बज्या यत्र तत्र चापमृगौ ।
उदयं न गच्छतोऽस्तं न गच्छतः कर्किमिथुनराशी द्वौ[2] ॥ ५० ॥

इत्येतत् सहेतुकमाह—सर्वस्मादिति । दृश्यमानोऽयं समुद्रः सगरैः कृतः, न तु साक्षात्समुद्र इति वेद्यम् । समीपगोऽब्धिभागोऽत्राङ्गीकृतः ।

४७. दिनवृद्धिक्षययोर्विषयमाह—सौम्ये निरक्षेति ।

४८-४९. यत्र परमं चरदलं पञ्चदशनाडिकात्मकं भवति तं देशमाह—यस्मिन्निति । तत्र मिथुनान्तगतेऽर्के त्रिंशद्घटिका दिनवृद्धिः स्यात् । अतो रात्रिर्न संभवति । षष्टिनाडिकात्मकदिनं भवति । अत उपरिदिनेन सहितं तद्दिनं प्रायः [b]खरविनाडिकात्मकं स्यात् । विंशत्यधिकशतनाडिकाप्रमाणं प्रायः स्यात् । उपरिदिने चरदलस्य किंचिन्न्यूनत्वादस्तमयः संभवति । अतः किंचिदूनविंशत्यधिकशतनाडिकाप्रमाणं दिनं भवतीति प्रायःशब्दस्यार्थः । चापान्तगतेऽर्के तद्वद्रात्रिश्च षष्टिनाडिकाप्रमाणा । इत उत्तरदेशे उदग्गमनवशात् त्रिदिनपञ्चदिनदशदिनार्धमासैकमासद्विमासत्रिमासादितुलितमेकदिनं संभवति ।

५०-५१. यत्र चापमृगौ राशी उदयं न गच्छतः, मिथुनकर्कटावस्तं च न गच्छतः, तं देशमाह—राशिद्वयेति । तत्र मिथुनकर्कटधनुर्मृगेभ्योऽन्येषामष्टानां राशीनामेव लग्नत्वं संभवति ।

[1] F. योग.

[2] F. स्यात्.

[a] शशीत्यादि 3141.

[b] खरवीति 120.

अष्टानामेव तनौ लग्नत्वं भवति तत्र राशीनाम् ।
हरिजस्पर्शाभावाल्लग्नत्वं नैणकर्कियमधनुषाम् ॥ ५१ ॥
एकक्षापमतुल्या लम्बज्या यत्र तत्र वृषभाद्याः ।
यान्ति न चत्वारोऽस्तं कौर्प्याद्या नोदयं च चत्वारः[1] ॥ ५२ ॥
वृषभाद्याश्चत्वारो मासा दिनमेकमेव[2] तत्र भवेत् ।
कौर्प्याद्या [3]रात्रिः स्यात् पूर्वत्र तु दिननिशे द्विमासौ स्तः ॥५३॥
परमापक्रमतोऽल्पा लम्बज्या यत्र तत्र[4] राशीनाम् ।
केषांचिदुत्क्रमात्स्याद् [5]उदयो गोले प्रदृश्यमखिलं तत् ॥ ५४ ॥
मेषाद्याः षण्णास्तं जूकाद्याः षट् तथा न यान्त्युदयम् ।
देशे तु[6] शून्यलम्बे [7]लग्नत्वं तत्र नास्ति कस्यापि ॥ ५५ ॥
विधिरयमुदितो भागे देवानां स्यात् पुनर्दितिजभागे[8] ।

५२-५३. यत्र वृषभाद्याश्चत्वारो राशयोऽस्तं न गच्छन्ति, वृश्चिकाद्याश्चत्वार उदयं न च गच्छन्ति तं देशमाह—**एकक्षेति** । तत्र एकक्षापमतुल्यलम्बे देशे । पूर्वत्र द्विराश्यपक्रमतुल्यलम्बे देशे ।

५४. यत्र केषांचिद्राशीनां उत्क्रमेणोदयः स्यात्, केषांचित् क्रमेण, तं देशमाह—**परमापमिति** ।

५५. यत्र मेषादि[9]राशिषट्कं नास्तं गच्छति, तुलादिराशिषट्कमुदयं च न गच्छति, तं देशमाह—**मेषाद्याः षडिति । शून्यलम्बे देशे मेरौ** मेषादिमासषट्कमेकं दिनं भवति, तुलादिमासषट्कं रात्रिर्भवति ।

५६. देवभागाद् [illegible]येनासुरभागे दृश्यादृश्यभागावित्याह — **विधिरिति** ।

[1] The *pāda* is corrupt in some Mss. A. कुर्प्याद्यागेय . . . . श्च चत्वारः; C. कूर्प्याद्या गेयं च चत्वारः; D. कौर्प्यादयं च चत्वारः.

[2] B. मेवमेव. [3] C. रात्री. [4] A. B. C. D. F. omit तत्र.

[5] D. G. उदये. [6] D. G. देशेऽत्र. [7] A. C. F. लग्नं.

[8] F. दितिजानाम्. [9] A. omits राशि.

दृश्यादृश्यौ न्यस्तं लम्बत्वं देवभागवद्धानाम् ॥ ५६ ॥
चरसंस्कृतिर्न [1]चिन्त्या विलक्षणा यत्र राशयस्तत्र ।
तत्र हि चरसंस्कारान्मृगादिषट्कस्य भवति शून्यत्वम् ॥ ५७ ॥

[देवादीनां दिनमानम्]

शशिबिम्बस्योर्ध्वगताः पितरः पश्यन्ति चान्द्रमासार्धम् ।
मनुजाः कुदिनार्धमिनं रविवर्षार्धं सुरास्तथा दितिजाः ॥ ५८ ॥
ब्रह्मा तु युगसहस्रं पश्यति भानुं सदातिदूरगतम् ।
तावन्न पश्यति पुनर्ब्रह्माप्यर्कं रवेरभावात्तत्[2] ॥ ५९ ॥
पुनरपि च युगसहस्रेऽतीते दिवसो भवेद्विधेस्तत्र ।
सृष्टा भवन्ति सर्वे देवाद्याः पूर्ववद्दिनाद्यपि च[3] ॥ ६० ॥
अष्टसहितं [4]सहस्रं विधेर्युगानां दिनं भवेदिति च ।
आर्यभटेन प्रोक्तं निशा भवेत्तावती हि[5] तत्पक्षे ॥ ६१ ॥

५७. यत्र परमापमादूनो लम्बः, तत्र राशीनां चरसंस्कृतिर्न चिन्त्येत्याह —चरसंस्कृतिरिति । विलक्षणाः प्रसिद्धलक्षणरहिताः, क्रमोदयप्राप्तिरहिता इत्यर्थः ।

५८-६१. पितॄणां मनुजानां देवासुराणां च ब्रह्मणश्च दिनमानमाह— शशिबिम्बस्येति । पितॄणां शशिबिम्बस्योर्ध्वभागस्थितत्वात् शशिमासार्धं कृष्णाष्टम्यर्धादि शुक्लाष्टम्यर्धान्तं रविदर्शनं स्यादित्यर्थः । कुदिनार्धं सावनदिनस्यार्धं मनुजा रविं पश्यन्ति । रविवर्षार्धं मेषादिमासषट्कं सुरा रविं पश्यन्ति । मेषादिषट्कस्य क्षितिजादूर्ध्वगतत्वात्[6] सदा सकृदुदितं रविं देवाः पश्यन्तीत्यर्थः । दितिजाश्च तथा रविवर्षार्धं तुलादिमासषट्कं सूर्यं पश्यन्ति ।

[1] F. repeats here कस्यापि to दितिजानां (verse 55-56 above) by some scribal error. [2] F. तम्. [3] G. पूर्ववद्दिनान्यपि (corrupt).
[4] G. अष्टसहस्रं सहितं. [5] G. ह. [6] A. गतित्वात्.

[पौराणिकं भूगोलवर्णनम्]

श्रीपतिना तु प्रोक्ताः सप्तद्वीपादयोऽपि भूगोले ।
तद्विषयगतः [1]किंचिद्विलिख्यतेऽस्माभिरपि च बालेभ्यः ॥ ६२ ॥

[सप्त द्वीपाः समुद्राश्च]

जम्बूश्च प्लक्षाख्यः [2]शाल्मलकुशसंज्ञितौ तथा क्रौञ्चः ।
[3]शाकः पुष्कर इत्यपि सप्तैते मध्यतः क्रमाद्द्वीपाः ॥ ६३ ॥
लवणेक्षुसुराज्यदधिक्षीरजलैरावृताः समुद्रैस्ते ।
ऊर्ध्वार्धे जम्बूः स्याद्भूमेरन्ये त्वधोदले षट् स्युः ॥ ६४ ॥

[जम्बूद्वीपः मेरुश्च]

मेरुः कनकमयः स्याज्जम्बूद्वीपस्य पर्वतो मध्ये ।
भूपद्मस्यास्यासौ मध्यस्थः कर्णिकाकारः ॥ ६५ ॥

ब्रह्मा स्वदिनयुगसहस्रं स्वस्थानादतिदूरगतं रविं पश्यति । अतिदूरगतत्वात् भूमेः परितो[4] भ्रमतोऽस्य भूम्या व्यवधानं न भवतीत्यर्थः । स्वनिशि प्रलयकाले, ब्रह्मापि रवेरभावात् तं न पश्यति । प्रलयावसानस्याहन्यादित्योऽपि सृष्टो भवति । अतस्तं ब्रह्मापि पश्यति । पितृमनुजसुरदैतेयाश्च पूर्ववत्पश्यन्ति ।

६२. श्रीपतिनाम्ना आचार्येण स्वकृतगणिततन्त्रे सप्त द्वीपाः सप्त समुद्राश्च भूमेः खण्डभेदादयश्चोक्ताः । अतोऽस्माभिरपि बालानां हिताय तद्विषयं किंचिद्विलिख्यत इत्याह—श्रीपतिनेति ।

६३. द्वीपादीनाह—[5]जम्बूरित्यादिभिः ।

[1] B. कथित.
[2] A. शामल; D. शान्मल.
[3] F. शाखा.
[4] A. भ्रमणतो.
[5] A. has an extra द्वीप after this.

[जम्बूद्वीपविभागः]

जम्बूद्वीपे नवकं खण्डानां स्यादिलावृतं[1] मध्ये ।
भारतकिंपुरुषाभिधहरिवर्षाख्यानि लङ्कातः ॥ ६६ ॥
मेरोर्याम्ये सौम्ये रम्यकहिरण्मयं[2] च कुरुवर्षम् ।
सौम्यान्ताद्[3] भद्राश्वः[4] पूर्वे पश्चात्तु केतुमालाख्यः ॥ ६७ ॥

[जम्बूद्वीपे पर्वतादयः]

इति खण्डनवकमुक्तं परितो मेरोरिलावृतं तत्र ।
विष्कम्भाख्याश्च नगाश्चत्वारो मेरुपार्श्वगताः ॥ ६८ ॥
मन्दरसगन्धमादनविपुलसुपार्श्वाः क्रमेण पूर्वादौ ।
तच्छिरसि दिव्यतरवः कदम्बजम्ब्वाख्यपिप्पलवटाख्याः ॥ ६९ ॥
एते हि महाकाया जम्बूद्वीपाख्यहेतुरपि जम्बूः ।
चैत्ररथगन्धमादनवैभ्राजकनन्दनानि च वनानि ॥ ७० ॥
पूर्वादिष्वरुणोदं मेरोस्तु सितोदमानसाख्ये च ।
तद्वन्महाह्रदाख्यं सरांसि चत्वारि देवानाम् ॥ ७१ ॥
इति मध्यमखण्डोऽष्टौ सीमाख्याः पर्वताः स्युरन्येषाम् ।
हिमवांश्च हेमकूटो निषधो याम्ये, तथोत्तरे मेरोः ॥ ७२ ॥
नीलः श्वेतः[5] शृङ्गी सप्त कुलागाः समेरुका ह्येते ।
पूर्वदिशि माल्यवान् स्यात्, पश्चिमगो गन्धमादनश्चेति ॥ ७३ ॥
केसरनगाश्च परितः, पूर्वे शीताम्भ इत्याद्याः ।
मेरोस्त्रिकूटकाद्या[6] याम्ये, सौम्ये तु शङ्खकूटाद्याः ॥ ७४ ॥

1 Mss. read वृती.
2 A. C. D. E. F. मयौ.
3 D. सौम्याता.
4 A. C. E. F. भाद्राश्वः; D. भाद्रश्वः.
5 All Mss. except G. read शेतः.
6 A. D. F. क in काद्या left out; G. काद्यो.

शिखिवासा इत्याद्याः पश्चादथ[1] कीर्तितानि पत्राणि ।
भूम्याख्यपद्मस्य तु[2] भद्राश्वा भारताश्चापि ॥ ७५ ॥
तद्वच्च केतुमालाः कुरवो ; मेरूर्ध्वगा[3] सभा तु विधेः ।
इन्द्रादीनां च पुरो ब्रह्मस्थानात्तु[4] दिक्ष्वपि विदिक्षु ॥ ७६ ॥

[जम्बूद्वीपे सरितः]

गङ्गा विष्णोः पादाद्विनिर्गता याति[5] विधिपुर्याम्[6] ।
सात्र चतुर्धा भूत्वा चरति प्रागादिषु च दिक्षु[7] ॥ ७७ ॥
सीतालकनन्दाख्या सुचक्षुरपि भद्रसंज्ञिता चेति ।
तत्तद्दिग्गता[8] वैश्वानचलानपि ता विलङ्घ्य यान्त्यब्धीन् ॥ ७८ ॥
याम्ये सालकनन्दा भारतगा सप्तभेदा स्यात् ।
अलकाद्यनलाद्यास्तासां प्रोक्तान्तरिक्षेण ॥ ७९ ॥

[अन्यद्वीपवासिनः]

किंपुरुषाद्येष्वष्टसु[9] वसतां वर्षेषु नैव दुःखानि ।
द्वादशसहस्रमायुर्वर्षाणां किंचिदधिकमूनं च ॥ ८० ॥
तेषु न वर्षति देवो भौमानि भवन्ति तत्र चाम्भांसि ।
नैव कृतत्रेताद्या युगभेदास्तत्र कल्प्यन्ते ॥ ८१ ॥
प्लक्षफलं किंपुरुषे हरिवर्षे शर्कराशनद्रव्यम् ।

1 B. has an extra च here.

2 A. D. ति for तु ; F. gap for तु and the next letter भ.

3 Mss. have a *visarga* after this.

4 G. स्त.

5 A. C. D. F. आन्ती (corrupt).

6 A. F. विधुपुर्याम् (corrupt).

7 F. प्रागादि दिक्षु दिक्षु.

8 A. E. गति corrected to गत.

9 E. G. द्येष्वष्टसु.

भद्राश्वे चूतफलं पनसं वर्षे तु [1]केतुमालाख्ये ॥ ८२ ॥
जम्बूफलं तथेलावृते पुनः रम्यके वटस्य फलम् ।
लिकुचं हिरण्मये स्यात् कुरुषु तु कल्पद्रुमक्षीरम् ॥ ८३ ॥

[भारतवर्षम्]

भारतवर्षं सौम्ये जलधेः स्याद्दक्षिणे हिमगिरेश्च ।
याम्याब्धिबिन्दु[2]सरसोर्मध्यगतं चेति तत्प्रोक्तम् ॥ ८४ ॥
एतद्धि कर्मभूमिर्यस्मादत्रैव पुण्यपापौ[3] स्तः ।
अत्रस्थाः पुण्यकृतः स्वर्गं नरकं [4]प्रयान्ति पापकृतः ॥ ८५ ॥
अन्येष्वस्माद्देशेष्वत्र कृतानां तु कर्मणामेव ।
अनुभवति फलं जन्तुस्तेषु न[5] पुण्यं भवेन्न पापं च[6] ॥ ८६ ॥

[भारतवर्षविभागः]

भारत[7]खण्डेऽप्यस्मिन्नव खण्डाः केनचित्प्रकारेण ।
पूर्वं[8] प्रकल्पिताः स्युः सगरसुतैस्तेऽपि चात्र लिख्यन्ते ॥ ८७ ॥
इन्द्रद्वीपकशेरू द्वौ [9]ताम्रपर्णो गभस्तिमांश्चैव ।
नागः सौम्यश्च तथा [10]गान्धर्वो वारुणस्तथेत्यष्टौ ॥ ८८ ॥
नवमोऽयं द्वीपः स्याज्जलनिधिसंवृतः कुमारीति ।
पूर्वेऽन्ते[11]ऽस्य किराताः पश्चाद्यवना द्विजादयो मध्ये ॥ ८९ ॥
अत्र कुमारीद्वीपे षडुपद्वीपा विनिर्दिष्टाः ।

[1] A. F. केतु left out.
[2] F. सिन्धु.
[3] G. पापे.
[4] F. प्र omitted.
[5] A. C. F. न left out.
[6] All Mss. except G. पापश्च.
[7] All Mss. except G. खण्डेष्वप्य.
[8] B. पूर्व.
[9] A. E. ताम्रपर्णौ.
[10] A. B. C. F. G. गन्धर्वो.
[11] A. C. E. F. पूर्वन्ते; D. पूर्वेऽन्त्ये.

अङ्गयवमलयशङ्खककुमुदवराहा इति ख्याताः ॥ ९० ॥

[भारतवर्षे पर्वताः]

सप्तान्यद्रयः[1] स्युः ऋक्षो महेन्द्रविन्ध्यौ च मलयसह्यौ च ।
तद्वच्च शुक्तिमान् स्यादपरः स्यात् पारियात्राख्यः ॥ ९१ ॥
वर्णाश्रमा इहैव व्यक्ततरा इति वदन्ति[2] शास्त्रविदः ।

[लङ्कास्थानम्]

मलयद्वीपगमलयाचलमध्यमशिखर[3]संस्थिता लङ्का ॥ ९२ ॥

[केरलः]

याम्योदगायता स्यात्पादे सह्यस्य [4]परशुरामोर्वी ।
क्षेत्राणि सप्तकोटीश्वर[5]मपि बिल्वपर्वताख्यं च ॥ ९३ ॥
गोकर्णोऽनन्तपुरं तत्रामलकं तु सह्यपादे स्यात् ।
एतानि विशेषेण प्रोक्तानि हि भुक्तिमुक्तिदानीति ॥ ९४ ॥

[भारतवर्षे पुण्यक्षेत्राणि]

काशीसाकेतमायोध्याकुरुक्षेत्रहरिहरादीनि ।
श्रीरङ्गमल्लिकार्जुनपुरुषोत्तमसंज्ञितादीनि ॥ ९५ ॥
दिव्यस्थानानि स्युर्देशेष्वन्येषु च बहूनि[6] ।
पापहराणि च तीर्थान्येषु स्युः स्पर्शना[7]न्नृणाम् ॥ ९६ ॥

[1] B. G. न्य left out; E. corrupt सप्ताद्रस्युतृक्षो.

[2] A. C. E. F. भिदन्ति.

[3] G. सं left out.

[4] A. B. C. corrupt परार्मोर्वी.

[5] A. B. C. E. F. कोटिश्वर.

[6] F. बहूनि left out.

[7] A.B.C. स्पर्शनं.

[भारतवर्षे नद्यः]

नद्यश्च शतद्र्वाद्या[1] हिमवत्पादाद्रिनिर्गताः[2] सन्ति ।
वेदस्मृतिवदनाद्या नद्यः स्युः पारियात्रभवाः ॥ ९७ ॥
[3]सुरसाह्वनर्मदाद्या विनिःसृता विन्ध्यतः प्रोक्ताः ।
तापी च पयोष्ण्याख्या निर्विन्ध्याद्यास्तथैव चर्क्षभवाः ॥ ९८ ॥
भीमरथापि च गोदावर्याद्याः सह्यपादभवाः ।
मलयोद्भवास्तु नद्यः [4]कृतमालाताम्रपर्ण्याद्याः ॥ ९९ ॥
ऋषिकुल्याद्या नद्यो महेन्द्रनगसंभवाः प्रोक्ताः ।
[5]ऋषिकूला च कुमारेत्याद्या अपि निःसृतास्तु शुक्तिमतः ॥१००॥
आसां[6] नद्युपनद्यश्चासंख्याः सन्ति मानवैः सेव्याः ।
संक्षेपादिति कथितो जम्बूद्वीपः सह विभागैः ॥ १०१ ॥

[अन्यद्वीपवासिनः]

[7]अन्येषु द्वीपेषु तु वसतां रोगादयो न स्युः ।
आयुः पञ्चसहस्रं वर्षाणां कीर्तितं तेषाम् ॥ १०२ ॥

[लोकान्तराणि]

पौराणिकैस्तु गदितं लोकाः सप्तेत्यथापि पातालः ।
लोकास्तु भूर्भुवःसुवर्महरिति च जनस्तपः सत्यम् ॥ १०३ ॥

[1] Mss. corrupt A. C. नद्यश्च . . . ताद्या; B. नद्यः शत . . द्याद्या; D. नद्यश्च शतुद्रयाद्या; F, G. नद्यश्च शतद्रयाद्या; E. alone has the correct reading.

[2] E. G. विनिःसृता. [3] A. C. सुरसाश्च. [4] F. घृत.

[5] F. ऋषिकन्याद्या. [6] D. E. F. आसन्.

[7] F. Verses 102-105 full of gaps.

भूमिर्भूर्लोकोऽतः खेटस्थानादधो भुवश्चापि ।
गन्धर्वयक्षराक्षसभूतपिशाचादिभिश्च पूर्णोसौ[1] ॥ १०४ ॥
स्वर्लोकस्तत ऊर्ध्वं दिव्यजनविमानखेटयुक्तोऽसौ ।
महराख्यस्तत ऊर्ध्वं वसिष्ठपुलस्त्यादिऋषिगणाकीर्णः ॥ १०५ ॥
तत ऊर्ध्वं च जनः स्याद् भृग्वादिमहर्षिगणपूर्णः ।
तप इति तस्मादूर्ध्वं पूर्णश्च महर्षिभिः स सनकाद्यैः ॥ १०६ ॥
सत्याख्यस्तत [2]ऊर्ध्वस्तस्मिन् ब्रह्मा च परमहंसाश्च ।
व्योम ततस्तस्यान्ते [3]ब्रह्माण्डकपालसंस्थितिर्भवति ॥ १०७ ॥
अतलवितलसुतलनितलतलातलमहातलरसातलाश्च ।
पातालाः सप्त भुवोऽन्तर्गताः स्यू रम्यभूमयस्ते च ॥ १०८ ॥
अष्टमहानागाद्यैरसुरैश्च महाबलिप्रमुखैः ।
ते पूर्णा इति चोक्तास्तद्वद्धयग्रीवादिभिश्चापि ॥ १०९ ॥
लोको नरका[4]ख्योऽधस्तदधस्तथोपनरकाख्यः ।
ब्रह्माण्डकपालोऽधो[5] गदितं[6] पौराणिकैरेवम्[7] ॥ ११० ॥

इति गोलदीपिकायां भूम्यादिचिन्तनाख्यः[8]
तृतीयोऽध्यायः

इति भूम्यादिविषयस्तृतीयः

[1] A. C. श्चासौ, &c., पूर्ण left out; F. च left out.
[2] E. G. ऊर्ध्वे.
[3] A. C. ब्रह्मान्तकाल (corrupt).
[4] F. ख्योर्ध्वं (wrong).
[5] E. कपालोऽतो.
[6] E. गदितः.
[7] G. [illegible]
[8] G. the word missing.

चतुर्थोऽध्यायः

[भूसूत्रम्]

क्षितिजापरक्षितिजयोर्बद्धं भूमध्यगं च भूसूत्रम् ।

[शङ्कुच्छाये]

अवलम्बितं हि सूत्रं सूर्याच्छङ्कुर्भवेत् कुसूत्रान्तम् ॥ १ ॥
भूमध्यान्तं शङ्कोर्मूलाच्छाया[1] च तत्र निर्दिष्टा ।
दो:कोटी ते द्वे स्तः, कर्णस्त्रिज्या तयोस्त्रिभिस्त्र्यश्रम् ॥ २ ॥
क्षितिजार्कयोस्तु विवरे द्युवृत्तजा ज्याथवात्र कर्णः स्यात् ।
कोटिः स्याद्धि शङ्कुर्बाहुः शङ्क्वग्रमत्र च त्र्यश्रम् ॥ ३ ॥

१a. अथ शङ्कुच्छायादीनां स्वरूपाद्याह—क्षितिजेति ।

१b-२. क्षितिजसमानसमतलज्ञानार्थमत्र भूसूत्रं प्रकल्प्यते—अवलम्बितं हीति । समतलाद्रवेरुन्नतिमानं शङ्कुरित्यर्थः । ते द्वे शङ्कुच्छाये दो:कोटी भवतः । तयोः कर्णः त्रिज्या स्यात् । एवं दो:कोटिकर्णैः [2]त्र्यश्रं क्षेत्रं भवति । दो:कोटयोर्नामभेद एव । एका भुजा, इतरा कोटिरित्येवार्थः ।

३. शङ्क्वाश्रितं[3] क्षेत्रान्तरमाह—क्षितिजार्कयोरिति । अथवा अर्काश्रितद्युवृत्ते क्षितिजान्ता जीवा[4] इष्टद्युज्या, सा कर्णः, शङ्कुः कोटिः, शङ्क्वग्रं बाहुः । एवमेभिश्च त्र्यश्रं भवति । एतदक्षनिमित्तं क्षेत्रम् । शङ्क्वग्रभूज्याक्षज्याद्याश्रितानि क्षेत्राणि सर्वाण्यप्यक्षनिमित्तानि । तेष्वेकत्र भवैः बाह्वादिभिः इतरक्षेत्रभवबाह्वाद्यानयनम्[5] अनुपातात्कार्यम्[6] । तदत्र क्षेत्रज्ञानप्रयोजनम् ।

[1] A. B. corrupt alternate reading त्रिभ्रवा for मूलाच्छाया written beneath the word.

[2] A. त्र्यश्र. [3] A. श्रित. [4] A. स्तजीवा.

[5] B. omits आनयनम्. [6] B. कल्प्यम्.

[1]कालज्यया हि[2] साध्या द्युवृत्तगाज्यानुपातेन ।
इयती त्रिज्यावृत्ते यदि कियती स्यात्तदा द्युवृत्त इति ॥ ४ ॥
उन्मण्डलाद्धि युक्तं जीवाग्रहणं सदापि हरिजाच्च[3] ।
उन्मण्डलमेव यतो भ्रमतो गोलस्य पार्श्वगं भवति ॥ ५ ॥
चरदलहीनयुतानामतो दिनस्यैष्ययातजासूनाम् ।
जीवा चरज्ययापि च युतहीना गोलयोस्तु कालज्या ॥ ६ ॥

[इष्टशङ्क्वानयनम्]

त्रिज्याश्रुतेर्यदि स्याल्लम्बः कोटिस्तदा कियती ।
इष्टद्युवृत्तजीवाकर्णस्येतीष्टशङ्कुरपि भवति ॥ ७ ॥

४. तत्त्रैराशिकं चैवमित्याह—कालज्ययेति । घटिकामण्डलगतघटिकादिकालज्यया स्वाहोरात्रेष्टज्यानुपातात्कल्प्या ।

५. गतगन्तव्यकालस्य हरिजादुत्पन्नत्वेऽपि जीवाग्रहणमुन्मण्डलादुत्पन्नस्य कालस्यैव युज्यत इत्याह—उन्मण्डलाद्धीति । तत्र हेतुमाह—उन्मण्डलमेवेति । जीवा हि वृत्तपादे कल्प्यते । गोलभ्रमणवृत्तस्य मध्यगतमुन्मण्डलमेव भवति । अतो गोलभ्रमणवृत्तजातजीवाग्रहणं तन्मध्यगतादुन्मण्डलादेव युज्यत इत्यर्थः । पार्श्वशब्देन अधऊर्ध्वभागयोर्मध्य उच्यते । अस्य जीवायां क्षितिजोन्मण्डलविवरजातजीवाः प्रक्षिप्य संशोध्य वा क्षितिजादुत्पन्नजीवासिद्धिः स्यात् ।

६. उन्मण्डलादुत्पन्नजीवाग्रहणोपायं तथा क्षितिजादुत्पन्नजीवानयनोपायं चाह—चरदलेति । कालज्या, क्षितिजादुत्पन्ना कालज्येत्यर्थः ।

७. कालज्यानीतया क्षितिजादुत्पन्नस्वाहोरात्रेष्टज्यया कर्णात्मिकया कोटिरूपस्य शङ्कोरानयने त्रैराशिकमाह—त्रिज्याश्रुतेरिति ।

[1] F. omits this line.
[2] A. B. C. तु for हि.
[3] A. B. D. E. F. G. हरिजान्ते,

[शङ्कग्रानयनम्]

लम्बककोट्यास्तु[1] भुजा यद्यक्षज्यात्र शङ्कुकोट्याः[2] का ।
स्यादिति शङ्कग्रं स्यात्, क्षेत्रं निखिलं यतोऽक्षजमिह स्यात् ॥ ८ ॥
अथवेष्टद्युज्याघ्ना क्रान्तिज्यार्काग्रया हृता[3] शङ्कुः ।
भुज्यानिहताच्छङ्कोः शङ्कग्रं क्रान्तिजीवयाप्तं[4] स्यात् ॥ ९ ॥

[समशङ्कुः]

अर्के सममण्डलगे स्वर्काग्रासंमितं हि शङ्कग्रम् ।
समशङ्कुरस्तः साध्यो रव्यग्राख्यात् स्वशङ्कग्रात् ॥ १० ॥
[5]व्यस्तविधिनाथवा दोःकोटिभवेनानुपातेन ।
लम्बः पलस्य कोटिर्यदि शङ्कग्रस्य केति समशङ्कुः ॥ ११ ॥

८. शङ्कग्रानयने त्रैराशिकमाह—लम्बक[6]कोट्या इति । लम्बकोट्याः क्षेत्रान्तरगतत्वात् त्रैराशिकदोषमाशङ्क्य तद्[7]व्युदासार्थं 'निखिलं क्षेत्रं यतोऽक्षजम्' इत्युक्तम् ।

९. क्षेत्रान्तरगतैः कोटिभुजाकर्णैः शङ्कुशङ्क्वग्रयोरानयनं प्रदर्शयति—अथवेष्टेति ।

१०-११. सममण्डलशङ्क्वानयने युक्तिं प्रदर्शयति—**अर्के** इति । अक्षज्यागुणिताच्छङ्कोः लम्बकाप्ता हि शङ्कग्रम् । अतः शङ्कग्राल्लम्बकगुणितादक्षज्ययाप्तः[8] शङ्कुरिति व्यस्तविधिः । दोःकोटिभवं त्रैराशिकं प्रदर्शयति—**लम्बः पलस्येति** ।

[1] D. G. कोटयोस्तु (corrupt).
[2] G. ट्यो: (corrupt).
[3] A. C. E. हृताद्. D. G. हृतः.
[4] All the MSS. except G. जीवाप्तं.
[5] A. C. F. व्यस्तं.
[6] Mss. omit क by haplography.
[7] A. omits तद्; B. omits त.
[8] A. गुणिताक्षज्याप्तः.

[कोणशङ्कुः]

पूर्वापररेखान्तं शङ्कोर्मूलाद्[1] भुजा सदापि स्यात् ।
याम्योत्तररेखान्तं शङ्कोर्मूलात्तथैव[2] कोटिः स्यात् ॥ १२ ॥
[3]छाया च तयोः कर्णस्तैरिष्टाशास्थ[4]शङ्कुरपि साध्यः ।
समयोः शङ्कुच्छायाकर्णयोर्युतिभिन्नयोस्तयोर्भेदः ॥ १३ ॥
[5]छायाकर्णस्य भुजा, कोटिस्ताभ्यां प्रसाध्यात्र ।
कोटितुल्या यदा स्याद् भुजा तदा कोणगो रविर्भवति ॥ १४ ॥

१२-१३a. अथेष्टाशास्थशङ्क्वानयनार्थं छायाकर्णक्षेत्रभुजां कोटिं च प्रदर्शयति—पूर्वापररेखान्तमिति । त्रिज्यावृत्तमालिख्य दिक्सूत्रे च कुर्यात् । तस्मिन् वृत्ते यत्र महाशङ्कोर्मूलं तत्काले भवति, [6]केन्द्रान्महाच्छायान्तरे हि तद्भवति[7] । तस्मात् शङ्कुमूलात् पूर्वापररेखान्ता याम्योदगायता महाच्छाया-कर्णस्य भुजा भवति । तस्माच्छङ्कुमूलात्[8] याम्योत्तररेखान्ता पूर्वापरायता छायाकर्णस्य कोटिर्भवति । एवं सदा छायावृत्ते भुजाकोटी भवतः । कर्णस्तु महाच्छाया । [9]एतैः भुजाकोटिकर्णैः [10]इष्टदिक्संस्थे सवितरि शङ्कुः साध्यः ।

१३b.-१४a. छायाभुजानयनमाह—समयोरिति । छायाकर्णस्य भुजा शङ्कुमूलात् पूर्वापररेखान्ता रेखेत्यर्थः । ताभ्यां भुजाकर्णाभ्यां कोटिश्च साध्या । तयोः वर्गान्तरपदं कोटिरित्यर्थः । सा हि शङ्कुमूला दक्षिणोत्तररेखान्ता भवति ।

१४b १८a. यस्मिन् काले छायाकर्णस्य भुजाकोटी समे भवतः, तदा रविः कोणदिग्गतो भवति । अतस्तदानीं दृष्टः शङ्कुः कोणशङ्कुर्भवति । अविशेषविधिना भुजाकोट्योः साम्यं कृत्वा कोणशङ्कुः साध्यः । अविशेष-

[1] A. B. C. E. मूला.   [2] D. मूलस्तथैव.   [3] B. E. G. छायात्र.

[4] Mss. read wrongly शास्थ.

[5] F. Verses 14-18, full of gaps.

[6] Extra न्मु after कृन्द्रा in Mss. In B. it is deleted by the scribe himself. B. महा corrected to मह.

[7] A. B. भवति repeated in Mss.   [8] A. मूलया.

[9] A. एतैः.   [10] A. वि for इष्ट.

अविशेषविधिर्बुद्ध्या[1] कार्यः[2] स्यात् कोणशङ्कु...
याम्येऽल्पा कोटिश्चेच्छोध्यं किंचिद्गतैष्यनाडीषु ॥ ...
तत्राल्पो बाहुश्चेद्योज्यं किंचिद्गतैष्यनाडीषु ।
सौम्यस्थेऽर्केऽप्येवं भानुस्तद्भाग एव चरति[3] यदि ...
चारः स्यादुभयोश्चेत्प्राग्वत्तत्रापि याम्यशङ्कासिद्धै ।
व्यस्तमुदक्छङ्कासिद्धै शोध्यादेर्मानमत्र बुद्ध्योह्यम्[4] ।
दोःकोट्योर्भेदोऽन्यैर्विशोध्यते दीयतेऽसुषु तथैव ।

[इष्टाशास्थशङ्कुः]

इष्टदिशं परिकल्प्य त्रिज्यावृत्ते तदुद्भवा दोर्ज्या ॥ ...

प्रकारमाह—याम्येऽल्पेति । पूर्वापररेखातो याम्यदिक्स्थे सवित... शङ्कौ साध्ये च सति, अभीष्टगतगन्तव्यघटिकासिद्धमहाच्छायाया... कोटिरल्पा चेत्, गतगन्तव्यनाडीषु किंचित्कालमानं शोध्यं भवति ... याम्यगतोऽर्क इत्यर्थः । तत्र कोटितो बाहुरल्पश्चेत् गतैष्यनाडीषु कि... योज्यं भवति । एवं दक्षिणगोले विधिः । सौम्यदिक्स्थो भानुः ... चरति चेत् सौम्यदिक्स्थशङ्कुसिद्ध्यर्थमेवमेव विधिः । सौम्य... दक्षिणदिशि च चरति चेत् तत्रापि याम्यदिग्गतशङ्कुसिद्ध्यर्थं ... योजने स्तः । तत्रोदक्छङ्कुसिद्ध्यर्थं तु व्यस्तं शोधनयोजने ... शोध्यस्य क्षेप्यस्य[5] वा मानं बुद्ध्या ऊह्यम् । अथवा दोःको... प्राणा गतगन्तव्यप्राणेषु शोध्या देया वा भवन्ति । पुन... यावद् भुजाकोटयोः साम्यं भवति । तत्राविशिष्टः शङ्कुः कोण...

१८b-२२. एवं कोणशङ्कुं संसाध्य पुनरिष्टदिक्स्थे... विशेषमाह—इष्टदिशमिति । त्रिज्यावृत्ते हि विदिक्स्थेऽर्के ...

[1] A. C. common corruption बध्या. [2] A. B. ...

[3] G. omits यदि.

[4] B. C. बुद्ध्योह्यम्. [5] A. क्षेप...

[उदाहरणम्]

[1]छायायां किंचिदुदाहरणं प्रदर्श्यते[2] ।

उद्देशकः—

स्फुटरविरजमध्यस्थः समशङ्कुः कोऽग्निदिक्स्थशङ्कुरपि ।
वाच्योऽग्निशक्रयोरपि मध्यस्थोऽ[a]धृब्धिरसमिताक्षज्या ॥ २३ ॥

२३. उदाहरणमाह[3]—स्फुटरविरिति । मेषमध्यगतः स्फुटरविर्यदा भवति तदा समशङ्कुर्वाच्यः । तदानीं कोणगतार्कस्य शङ्कुश्च वाच्यः । अग्निशक्रयोर्मध्यगतार्कस्य शङ्कुरपि वाच्यः । सममण्डलगतार्कस्य शङ्कुः समशङ्कुरिति उच्यते । [4]सप्ताब्धिषण्मिता यत्र अक्षज्या तत्र देशे एते शङ्कवो वाच्याः । इत्युद्देशकवचनम् ।

[5]अत्र [b]सप्ताब्धिरसमिता[6]क्षज्या[7] । ततः सिद्धा लम्बज्या [c]सप्ताद्रिरामदहन तुलिता । अस्मादर्का[8]त्सिद्धार्काग्रा [d]वसुरसाग्नितुलिता । सा लम्बघ्ना अक्षज्यया हृता समशङ्कुः स्यात् । स च [e]चन्द्राश्विगोविधुतुल्यः स्यात् ।

[1] A. C. D. have an extra त्रि before छायायां. G. छायाया.

[2] D. G. प्रदृश्यते.

[3] A. omits this word.

[4] A. corrupt सर्वाब्धिपिण्डिता.

[5] E. अत्र omitted.

[6] B. D. E. षट्संख्या for रसमिता.

[7] E. अक्षज्या omitted.

[8] A. C. E. F. अक्षात् for अर्कात्. A. C. सिद्धाग्रा for सिद्धार्काग्रा.

a अद्रीत्यादि 647.

b सप्ताब्धीत्यादि 647.

c सप्ताद्रीत्यादि 3377.

d वस्वित्यादि 368.

e चन्द्राश्वीत्यादि 1921.

कोणशङ्क्वर्थं[1] कल्पिता द्युगतनाड्योऽष्टौ । तैः सिद्धशङ्कुः [a]षडेकशराश्वितुलितः । शङ्क्वग्रं [b]द्व्यष्टवेदतुलितम् । तच्छाया [c]त्र्यब्धिरामाक्षितुलिता[2] । सा कर्णः । अत्राकाग्रा [d]वसुरसाग्निमिता । शङ्क्वग्राकाग्रयोः भिन्नदिशोर्भेदः[3] छायाकर्णस्य भुजा भवति । सा च [e]वेदैकभूमिता । तस्या[4] भुजायाश्छायायाश्च वर्गभेदमूलं कोटिः । सा च [f]खवेदरामाक्षितुलिता । तत्र भुजाकोट्योरतौल्यात्तयोरन्तरं[g] पूर्वसिद्धेषु घटिकाष्टकभवेषु द्युगतासुषु[h] [5]कोट्या आधिक्यात् प्रक्षेप्यम् । तथा सिद्धा द्युगतासवः [i]षड्गगनविधुबाणतुलिताः । तैः सिद्धः शङ्कुः [j]स्वरशून्यवेदाग्नितुलितः । छाया [k]वसु[6]रसाब्धिमिता । छायाबाहुः [l]शरवसुदस्रतुलितः । तत्कोटिः [m]दस्ररसाग्नितुलिता । [7]अत्रापि कोट्या आधिक्यात [8]दोःकोट्योरन्तरं[n] द्युगतासुषु[o] क्षेप्यम् । तथागता[9] द्युगतासवः [p]त्रिवसु[10]शशिबाणतुलिताः । एतैरपि शङ्क्वादीनानीय पूर्ववत्कर्माविशेषान्तं कार्यम्[11] । अविशेषविधौ यत्र भुजातः[12] कोटिरूना भवति, तत्र भुजाकोट्यन्तरं द्युगतासुषु विशोध्य शङ्क्वादि साध्यम् । एवमविशिष्टोऽत्र कोणशङ्कुः [q]शक्राब्धिरामतुलितो भवति ।

1 A. B. C. F. शङ्क्वग्रं (corrupt).
2 D. G. त्र्यक्ष्यब्ध्यक्षि (2423) तुलिता, कर्णः (wrong).
3 G. भेदे.
4 D. G. अस्या.
5 G. कोट्योः.
6 B. G. शशि for वसु.
7 G. तत्रापि.
8 B. दोःकोट्यन्तर.
9 B. तथाकृतात्.
10 B. वसु left out.
11 A. C. कार्यः.
12 A. B. C. E. तत्.

a षडेकेत्यादि 2516.
b द्व्यष्टेत्यादि 482.
c त्र्यब्धीत्यादि 2343.
d वसुरसेत्यादि 368.
e वेदैकेत्यादि 114.
f खवेदेत्यादि 2340.
g 2226.
h 2880.
i षडित्यादि 5106.
j स्वरेत्यादि 3407.
k वस्वित्यादि 468.
l शरेत्यादि 285.
m दस्रेत्यादि 362.
n 77.
o 5106.
p त्रिवस्वित्यादि 5183.
q शक्रेत्यादि 3414.

अथ शक्राग्न्योर्मध्यगतशङ्कानयनेऽपि[1] कल्पिता घुगतनाड्योऽष्टौ। एतैः सिद्धः[2] शङ्कुः [a]षडेकशराक्षितुलितः। तच्छाया [b]ऽयब्धिरामाक्षितुलिता। च्छायाभुजा [c]वेदैकभूमितुलिता स्यात्। अत्रेन्द्राग्न्योर्मध्यगतत्वाच्छङ्कोस्त्रिज्यावृत्ते वृत्तपादचतुर्थांशो(?शे)ऽभीष्टभुजा स्यात्। तद्भुजा[3] तत्कालमहाच्छायया[4] गुणिता त्रिज्याभक्ता दिग्बाहुर्भवति। यदि त्रिज्यावृत्ते इयती भुजा, तदा छायावृत्ते कियतीति त्रैराशिकम्। तथा सिद्धो दिग्बाहुः [d]षडङ्कवसुतुलितः[5] स्यात्। अत्र बाह्वोरसमत्वाद् दिग्बाहोराधिक्याच्च तद्बाह्वोः [e]अन्तरं घुगतासुषु[f] प्रक्षिप्य तद्घुगतवशाच्छङ्कादिमानीय पूर्ववद् बाहुद्वयं साध्यम्। तत्र बाह्वन्तर[6]युता[7] घुगतासवो [g]द्विरसषड्राम-[8]तुलिताः स्युः। तत्सिद्धः शङ्कुः [9]भूम्यद्रिनवाक्षि[h]तुलितः। तच्छाया [10]खाग्निसप्तेन्दु[i]तुलिता। छायाभुजा [11]विधुखाब्धि[j]तुलिता। दिग्भुजा [k]द्विषड्रसमिता।

[1] A. C. E. G. वि for पि corrupt; F. अपि omitted.

[2] F. तत्सिद्धः.

[3] B. G. भुजज्या.

[4] D. G. छाया.

[5] A. B. C. E. omit वसु.

[6] B. र left out.

[7] A.B.C.E.G. घुगता for घुयुता (corrupt).

[8] D. G. षड् omitted.

[9] Mss. corrupt; A. C. D. भूम्यादिना; B. भुम्यद्दिना; G. भूम्यद्रि गम्याक्षि.

[10] E. गो for खा.

[11] D. G. विधुखाग्नि for विधुखाब्धि.

a षडेकेत्यादि 2516.

b ऽयब्धीत्यादि 2343.

c वेदैकेत्यादि 114.

d षडङ्केत्यादि 896.

e 896—114=782.

f 2880.

g द्विरसेत्यादि 3662.

h भूम्यद्रीत्यादि 2971.

i खाग्नीत्यादि 1730.

j विधुखेत्यादि 201.

k द्विषडित्यादि 662.

अत्र छायाभुजादिग्भुजयोरीसमेर्मध्यं दृश्यते । अतस्तयोरन्तरं[a] द्विगुणितं [b]द्युगतासुषु प्रक्षिप्य तद्वशाच्छङ्क्वादि साध्यम् । तथासिद्धा[1] द्युगतासवः [c]कृताष्टशराब्धिमिताः स्युः । तत्सिद्धशङ्कुः [2]मन्वग्निराम[d]-तुलितः । छाया [e]तिथ्यङ्कतुलिता । छायाबाहुः [f]षड्रसाक्षितुलितः । दिग्बाहुः [g]खेष्वग्नितुलितः । अनयो[h]रन्तरमपि द्विगुणितं[i] द्युगतासुषु[j] क्षेप्यम् । [3]तत्र [4]द्युगतासवो [k]दस्रेषुसप्ताब्धितुलिताः । शङ्कुः[5] [l]द्विशराग्निराममितः । छाया [m]वेदरसाद्रिमिता । छायाबाहुः [n]वेदाद्रिदस्रतुल्यः । दिग्बाहुः [o]द्व्यङ्काश्वितुल्यः । [6]अत्रापि बाह्वन्तरं[p] [7]द्विगुणितं द्युगतासुषु[q] प्रक्षिप्य जाता असवो [r]वसुपन्नगसप्ताब्धितुलिताः । तच्छङ्कुः [s]खरसाग्निरामतुलितः । छाया [t]वसुदस्राद्रितुल्या । छायाबाहुः [u]षट्सप्ताश्वितुल्यः । दिग्बाहुः [v]वसुसप्ताश्वितुल्यः । अत्र बाह्वोरन्तरं द्विसंख्यमेव । तस्य द्विगुणितस्य द्युगतासुषु[w] प्रक्षेपाच्छङ्कोः एक[8]कलैवाधिक्यं स्यात् । अत [x]एकरसाग्निरामतुल्यः शक्राग्न्योर्मध्यगतः शङ्कुर्भवति । एवमिष्टदिग्गतः शङ्कुः साध्यः ।

[1] C. सिद्धं. [2] D. मुनि for मनु.
[3] A. C. तद for तत्र (common corruption). [4] E. omits द्यु.
[5] A. शङ्कुः to वेदरसाद्रिमिता left out; C. has this portion.
[6] G. अन्यत्र for अत्रापि. [7] D. द्विगुणितं left out.
[8] Mss. corrupt. A. C. D. तलैव; B. E. F. तलयैव; G. कलयैव.

a 461	*b* 3662.	*c* कृतेत्यादि 4584.
d मन्वित्यादि 3314.	*e* तिथीत्यादि 915.	*f* षड्रसेत्यादि 266.
g खेष्वित्यादि 350.	*h* 84.	*i* 168.
j 4584.	*k* दस्रेष्वित्यादि 4752.	*l* द्विशरेत्यादि 3352.
m वेदरसेत्यादि 764.	*n* वेदाद्रीत्यादि 274.	*o* द्व्यङ्केत्यादि 292.
p 18.	*q* 4752.	*r* वसुपन्नगेत्यादि 4788.
s खरसेत्यादि 3360.	*t* वसुदस्रेत्यादि 728.	*u* षट्सप्तेत्यादि 276.
v वसुसप्तेत्यादि 278.	*w* 4788.	*x* एकरसेत्यादि 3361.

[द्वादशाङ्गुलशङ्कुः]

इष्टद्युगतप्राणैस्तत्कालार्केण च प्रसाध्याः स्युः ।
शङ्कुतदग्रच्छायार्काग्राः ; [1]शङ्क्वग्रदिनकराग्रैक्यम् ॥ २४ ॥
दिवसाग्र्ये, [2]भिन्नदिशोश्च्छायाबाहुस्तयोर्भेदः ।
[a]अर्काङ्गुलस्य शङ्कोः प्रभा च साध्या गतासुभिरभीष्टैः ॥ २५ ॥
अर्काङ्गुलस्य शङ्कोः प्रभां महाच्छायया हरेद्धत्वा ।
छायाभुजया लब्धं त्वभीष्टवृत्ते [3]स्फुटेष्टभुजा ॥ २६ ॥

[शङ्कुच्छायाच्छेद्यकम्]

वृत्तं लिखे[b]दिनाङ्गुलशङ्कुप्रभया समे सदिक्सूत्रम् ।
[4]तस्मिन् पूर्वापरयोश्च्छाया[5]दिशि याम्यसौम्यदिक्स्थाग्राम्[6] ॥ २७ ॥

२४-२५a. अत्राभीष्टशङ्कोः छायाप्रमार्गपरिलेखनार्थं छायाभुजानयनं पूर्वोक्तमेव पुनरप्याह—इष्टद्युगतेति ।

२५b २६. महाच्छायावृत्तगतच्छायाभुजया द्वादशाङ्गुलशङ्कुच्छायाकृतवृत्ते छायानयनमाह—अर्काङ्गुलस्येति । अर्काङ्गुलच्छायां तत्कालजां पूर्वसाधितच्छायाभुजया हत्वा महाच्छायया हरेत् । तत्र लब्धम् अर्काङ्गुलशङ्कुच्छायया कृतेऽभीष्टवृत्ते इष्टा स्फुटभुजा भवति ।

२७ ३२a. लेखनप्रकारमाह—वृत्तमिति । तस्मिन् वृत्ते पूर्वापरसूत्रस्य पश्चार्धात् पूर्वार्धाच्च भुजातुल्यां शलाकां याम्योत्तरं नयेत्, यथा शलाकाया

[1] D. G. ग्र in शङ्क्वग्र left out.
[2] B. E. भिन्नदिशौ.
[3] A. D. स्फुटे left out.
[4] E. अस्मिन्.
[5] D. छाया left out.
[6] A. C. ग्रात्; G. ग्रा.

[a] अर्काङ्गुलेति 12.
[b] इनाङ्गुलेति 12.

[1]पृथगिष्टभुजाङ्गुलितां नयेच्छलाकां[2] यथा तदग्रयुगम् ।
प्रागपरसूत्रपरिधिस्थितं भवेत्कल्पयेच्च बिन्दुयुगम् ॥ २८ ॥
परिधिशलाकाग्रयुतौ पश्चिमभागे, तथा प्राच्याम् ।
दिक्सूत्रसंस्थमध्ये परिधिगताग्रद्वये शलाके वा ॥ २९ ॥
इष्टभुजद्विगुणमिते निधाय कार्यौ तदग्रगौ बिन्दू ।
दिनमध्यच्छायाग्रे शङ्कोरर्काङ्गुलकमितस्य ॥ ३० ॥
याम्योत्तराख्यसूत्रे तृतीयबिन्दुः पुनः कल्प्यः[3] ।
कुर्याद् [4]बिन्दुत्रितयस्पृग्वृत्तखण्डं तदुक्तमार्गेण ॥ ३१ ॥
तत्परिधिगताग्रैव छाया स्याद् वृत्तमध्यगशङ्कोः ।

अग्रद्वयं पूर्वापररेखायां वृत्तपरिधौ यावत्तिष्ठेत् । तत्र शलाकाग्रपरिधियोगे बिन्दुं कुर्यात् । एवं पश्चिमभागे पूर्वभागे च शलाकाग्रपरिधियुतौ बिन्दुद्वयं कुर्यात् । [5]यदा उत्तरदिशि शङ्कोश्छाया भवति, तदा उत्तरदिशि शलाका नीयते । यदा दक्षिणदिशि छाया वर्तते, तदा दक्षिणदिशि शलाका नीयते ।

शलाकास्थापनमेवं वा क्रियताम् । द्विगुणितभुजाङ्गुल्यां शलाकां पूर्वापररेखास्थमध्यां परिधिस्पृगग्रयां न्यस्य छायादिशि तदग्रपरिधियोगे बिन्दुं कुर्यात् । एवं पश्चिमभागे तथा पूर्वभागे चेति । एवं बिन्दुद्वयं स्यात् ।

पुनरर्काङ्गुलशङ्कोर्मध्यच्छायाङ्गुलितां शलाकां वृत्तमध्यगतां दक्षिणोत्तरसूत्रे छायादिशि नीत्वा तदग्रे तृतीयबिन्दुं कुर्यात् । एतद्बिन्दुत्रयस्पृग्वृत्तखण्डं छायावृत्तान्तर्गतं भवति । तत्परिधिगताग्रा सदा छायावृत्तमध्यस्थशङ्कोश्छाया भवति । बिन्दुत्रयस्पृग्वृत्तं तदुक्तमार्गेण कार्यं, त्रिशर्करा(? त्रिस्पृक्सूत्र)विधानेनेत्यर्थः ।

[1] G. पृथगभीष्ट. [2] A. C. G. छायाङ्गु; E. शलंका (corrupt.)
[3] G. परिकल्प्य, for कल्प्यः.
[4] A. C. बिन्दुत्रितयं; G. त्रितयस्य वृत्तं. [5] A. यथा.

[शङ्कुस्वरूपम्]

क्रमहीनोर्ध्वो [1]वृत्तस्तीक्ष्णाग्रोऽर्काङ्गुलोऽत्र शङ्कुः स्यात् ॥ ३२ ॥

[दोषरहितच्छायाभ्रमणरेखा]

[2]कालद्वयसूर्याभ्यामन्यैश्छायायुगं [3]च बाहुयुगम् ।
कृत्वा स्वे स्वे वृत्ते बाह्वग्रे कल्पयेत च बिन्दुयुगम् ॥ ३३ ॥
पूर्वापरकालभवक्रान्त्यो[4]र्भेदान्न दोष इह भवति ।
छायाभ्रम इति[5] गदितो **गोलविदा**[6] युक्तिरपि[7] च दृश्यात्र ॥ ३४ ॥
बिन्दुत्रितयं केन्द्रं कृत्वा वृत्तत्रयं समं विलिखेत् ।
मत्स्यद्वयं यथा स्यात्, मत्स्यद्वयमध्यगे नयेत्सूत्रे ॥ ३५ ॥
तत्सूत्रयोस्तु योगे केन्द्रं कृत्वैकबिन्दुगं[8] वृत्तम् ।
कुर्यात्तस्मिन्[9] वृत्ते तिष्ठन्ति हि बिन्दवस्त्रयोऽपि च ते ॥ ३६ ॥

३२b. अत्र शङ्कुर्वृत्तः क्रमाद्धीनोर्ध्वभागस्तीक्ष्णाग्रो ग्राह्य इत्याह—क्रमहीनेति ।

३३-३४. पूर्वापरकाल्योः क्रान्तिभेदाज्जातं दूषणमाशङ्क्य तत्परिहारार्थं प्रकारान्तरमाह—कालद्वयेति । समैर्गतगन्तव्यासुभिश्छायाद्वयं तद्बाहुद्वयं च पूर्वाह्णकालजैरपराह्णकालजैश्च साधनैर्यथाविध्यानीय पूर्वाह्णच्छायावृत्ते तद्बाह्वग्रे प्रथमबिन्दुः, अपराह्णच्छायावृत्ते तद्बाह्वग्रे द्वितीयो बिन्दुः, मध्याह्नच्छायाग्रे तृतीयबिन्दुरित्यर्थः ।

३५-३६. बिन्दुत्रयस्पृग्वृत्तलेखनोपायमाह—बिन्दुत्रितयमिति ।

[1] A. C. वृत्तस्तीक्ष्णाग्रा ; G. वृत्तस्तीक्ष्णाग्रे.
[2] A. च in. कालद्वय omitted.
[3] A. च omitted.
[4] Mss read भे.
[5] B. गदिते.
[6] A. C. गोलविदो (common corruption).
[7] D. G. युक्तिरत्र for युक्तिरपि च.
[8] All Mss. except G. गतं.
[9] E. अस्मिन्.

[कोणच्छायातः रव्यानयनम्]

कोणस्थोऽर्को यस्मिन् काले तस्माद्दिनार्धपर्यन्तम् ।
कालं विद्याद् घटिकायन्त्रेण[1] नताह्वयः स कालः स्यात् ॥ ३७ ॥
कोणप्रभार्ककृत्योर्योगपदं भवति कोणभाकर्णः ।
कोणप्रभाश्रुतिनरैः साध्ये कोणस्थशङ्कुदृग्ज्ये च ॥ ३८ ॥
कोणगतेऽर्के छायाकर्णस्य समे स्मृते भुजाकोटी ।
छायावर्गार्धपदं तस्मान्मानं भुजाकोट्योः ॥ ३९ ॥
पूर्वापरायता स्यात्कोटिर्याम्योदगायता[2] भुजा ।
छायाकोटिसमा स्यात् पूर्वापरगा द्युवृत्तकोटिरपि ॥ ४० ॥
कोटिर्घटिकावृत्ते पूर्वापरगा नतज्यया तुलिता ।

३७. कोणच्छायया तत्कालनतकालेन च स्फुटार्कानयनमाह—कोणस्थ इति । कृतदिग्विभागवृत्ते शङ्कुच्छायया हि कोणस्थितिरर्कस्य वेद्या । मध्याह्नकालश्च तस्मिन् वृत्ते छायया वेद्यः । नाडिकास्थापनेन तत्कालश्च वेद्यः ।

३८. तत्र कोणस्थद्वादशाङ्गुलशङ्कुच्छायया कोणस्थमहाशङ्कु-महाच्छाययोरानयनमाह—कोणप्रभेति ।

३९. कोणस्थेऽर्के भुजाकोट्योः साम्यात् छायाख्यस्य कर्णस्य वर्गार्धपदं भुजामानं कोटिमानं चेत्याह—कोणगतेऽर्क इति ।

४०a. भुजाकोट्योः स्थानमाह—पूर्वापरेति ।

४०b. द्युमण्डले दक्षिणोत्तरशलाकार्कयोर्विवरगतद्युवृत्तकोटिज्यायां छायाकोटिसाम्यमाह—छायाकोटिसमेति ।

४१. सूर्याधिष्ठितद्युमण्डलभागसमो यो घटिकामण्डलस्य भागस्तद्भाग-दक्षिणोत्तरशलाकयोरन्तरालगतघटिकामण्डलकोटिज्यायाः नतकालजीवासाम्य-

[1] Ms. read यन्त्रेण. [2] A. C. दृगायता for दगायता.

[कोणच्छायातः रव्यानयनम्]

कोणस्थोऽर्को यस्मिन् काले तस्मादिनार्धपर्यन्तम् ।
कालं विद्याद् घटिकायन्त्रेण[1] नताह्वयः स कालः स्यात् ॥ ३७ ॥
कोणप्रभार्ककृत्योर्योगपदं भवति कोणभाकर्णः ।
कोणप्रभाश्रुतिनरैः साध्ये कोणस्थशङ्कुदृग्ज्ये च ॥ ३८ ॥
कोणगतेऽर्के छायाकर्णस्य समे स्मृते भुजाकोटी ।
छायावर्गार्धपदं तस्मान्मानं भुजाकोट्योः ॥ ३९ ॥
पूर्वापरायता स्यात्कोटिर्याम्योदगायतात्र[2] भुजा ।
छायाकोटिसमा स्यात् पूर्वापरगा द्युवृत्तकोटिरपि ॥ ४० ॥
कोटिर्घटिकावृत्ते पूर्वापरगा नतज्यया तुलिता ।

३७. कोणच्छायया तत्कालनतकालेन च स्फुटार्कानयनमाह—कोणस्थ इति । कृतदिग्विभागवृत्ते शङ्कुच्छायया हि कोणस्थितिरर्कस्य वेद्या । मध्याह्नकालश्च तस्मिन् वृत्ते छायया वेद्यः । नाडिकास्थापनेन तत्कालश्च वेद्यः ।

३८. तत्र कोणस्थयार्काङ्गुलशङ्कुच्छायया कोणस्थमहाशङ्कु-महाच्छाययोरानयनमाह—कोणप्रभेति ।

३९. कोणस्थेऽर्के भुजाकोट्योः साम्यात् छायाख्यस्य कर्णस्य वर्गार्धपदं भुजामानं कोटिमानं चेत्याह—कोणगतेऽर्के इति ।

४०a. भुजाकोट्योः स्थानमाह—पूर्वापरेति ।

४०b. द्युमण्डले दक्षिणोत्तरशलाकार्कयोर्विवरगतद्युवृत्तकोटिज्यायां छायाकोटिसाम्यमाह— छायाकोटिसमेति ।

४१. सूर्याधिष्ठितद्युमण्डलभागसमो यो घटिकामण्डलस्य भागस्तद्भाग-दक्षिणोत्तरशलाकयोरन्तरालगतघटिकामण्डलकोटिज्याया नतकालजीवासाम्य-

[1] Mss. read यन्त्रेण. [2] A. C. दगायता for दगायता.

एवं स्थितेऽनुपातात्[1] स्वाहोरात्रार्धमपि च साध्यं स्यात् ॥ ४१ ॥
नतजीवया यदि स्यात् द्युवृत्तकोटिस्तदा कियती ।
त्रिभजीवयेति भवति स्वाहोरात्रस्य चार्धविष्कम्भः ॥ ४२ ॥
स्वाहोरात्रार्धात्[2] स्यात्क्रान्तिः, [3]क्रान्तेर्भुजाधनुरिनः स्यात्[4] ।
तेन युतं चक्रार्धं वोनं वा तेन रहितचक्रं वा[5] ॥ ४३ ॥
दक्षिणकोणच्छायावृद्धौ [6]याम्यं, भवेदयनम् ।

आह—कोटिर्घटिकेति । द्युवृत्तकोटिर्घटिकामण्डलकोटयोरेवं छायाकोटिनतज्याभ्यां साम्ये सति त्रैराशिकात् स्वाहोरात्रार्धविष्कम्भस्य सिद्धिः स्यात् ।

४२. तत्त्रैराशिकमाह—नतजीवयेति । स्वाहोरात्रार्धे विदिते तद्वर्गं त्रिज्यावर्गाद् विशोध्य शिष्टस्य मूलं क्रान्तिः स्यात् । क्रान्तिज्या त्रिज्याहता [7]परमक्रान्तिहृता सूर्यभुजाज्या[8] भवति । अस्या भुजाज्याया धनुरर्को भवति ।

४३. तेन चापेन युतं चक्रार्धं वा रविः, तेन चापेन हीनं चक्रार्धं वा रविः, तेन चापेन रहितं चक्रमण्डलं वा रविः, इत्येतदाह—स्वाहोरात्रार्धादित्यादिना ।

४४-४९. चक्रार्धेऽर्कस्य सूर्यस्य विभागो यो गोलदिग्भ्यां[9] वेद्य इति

[1] Mss. corrupt. A. नुखातान्; C. नुपातान्; E. सितेनुपतान्; D. स्थितेरनुपातात्.

[2] त् missing in Mss. In B. the original reading र्धा crossed out and र्धे written instead.

[3] D. G. क्रान्तिः,

[4] All Mss. except F corrupt; A. B. नोः स्यात्; C. नो स्यात्; D. G. नो स्याः; E. ना स्या.

[5] D. रहितचक्रार्धं वा; F. G. रहितचक्रार्धम् (corrupt).

[6] All Mss. except G. read याम्यो.

[7] A. परक्रान्ति. [8] A. सूर्यभुजाज्या. [9] B. यत्र गोलाभ्यां.

तत्र च्छायाह्रासे सौम्यं, याम्यं तु सौम्यकोणे[1] स्यात् ॥ ४४ ॥
दिवसद्वये[2] निरीक्ष्य छायामेवं प्रकल्पयेदयनम् ।
उदयाद् गोलविभागनिरताभ्यां निश्चीयतेऽत्र सूर्योऽपि ॥ ४५ ॥

[कोणच्छायातः अक्षानयनम्]

अविशेषकर्मणाक्षः[3] साध्यः स्यादुच्यतेऽत्र तस्य[4] विधिः ।
क्रान्तौ किंचित्क्षिप्त्वा तामर्काग्रां प्रकल्पयेदादौ ॥ ४६ ॥
[5]छायाबाहुदिनेशाग्रयोर्युति[6]र्भिन्नयोः, समदिशोस्तु ।
भेदः, शङ्क्वग्रं स्याच्छङ्कुकृतितदग्रवर्गयोगपदम् ॥ ४७ ॥
स्वाहोरात्रेष्टज्या, तया हरेत् त्रिभगुणघ्नशङ्क्वग्रम् ।
लब्धमिहाक्षज्या स्यादक्षगुणात्साधयेच्च लम्बज्याम् ॥ ४८ ॥

अयनगोलयोर्विभागमाह—दक्षिणकोणेति । दिवसद्वये निरीक्ष्य छायाया वृद्धिह्रासौ वेद्यौ । यदा पूर्वापरसूत्रात्सौम्यभागे उदयस्तदा सौम्यगोलगोऽर्कः । अन्यथा याम्यगोलग इति गोले वेद्ये ।

४६-५१. अस्मिन् कोणच्छायाविधानपक्षेऽप्यविशेषकर्मणा साध्यः स्यात् । तत्प्रकारमाह—क्रान्तौ किंचिदिति । एकद्वित्र्यादिसंख्याविशेषेण युतां क्रान्तिमर्काग्रामिति प्रथमं कल्पयेत् । तदर्काग्रच्छायाबाह्वोर्योगादन्तराद्वा[7] शङ्क्वग्रं भवति । शङ्क्वग्रशङ्कुवर्गयोर्योगपदं स्वाहोरात्रेष्टज्या भवति । तया स्वाहोरात्रेष्टज्यया त्रिराशिज्यागुणितं शङ्क्वग्रं हरेत् । तत्र लब्धम् अक्षज्या भवति । अक्षज्यातो लम्बज्या च सिध्यति । पुनस्त्रिज्यागुणितां क्रान्तिं लम्बकेन हरेत् । तत्र लब्धमर्काग्रा भवति । पुनस्तयार्काग्रया छायाबाहुना च

[1] D. G. कोण:. [2] D. G. द्वयं. [3] A. C. D. कर्णार्कः (corrupt).
[4] A. B. C. E. तत्र. [5] E. corrupt छायाबा.
[6] A. C. D. स्थान for युति (corrupt).
[7] A. योगान्तराद्वा, i.e. द missing. [8] A. शङ्क्वग्रं.

त्रिज्यागुणिता क्रान्तिर्लम्बकभजिता भवेदिनाग्रा च ।
प्राग्वच्छायाबाहुभ्रग्राग्राभ्यां[1] गवेश्य[2] शङ्क्वग्रम् ॥ ४९ ॥
शङ्क्वग्रशङ्कुकृत्योर्योगपदं स्याद् द्युवृत्तजेष्टज्या ।
शङ्क्वग्रं त्रिज्याघ्नं द्युवृत्तजीवोद्धृतं पलज्या स्यात् ॥ ५० ॥
लम्बश्च ततः क्रान्तेरर्काग्रा पूर्ववत्पुनश्चैवम् ।
अविशेषान्तं[3] कुर्यादविशिष्टा स्फुटतरा पलज्या स्यात् ॥ ५१ ॥

[मध्यच्छायातः अर्कानयनम्]

[4]मध्यच्छायातोऽपि च साध्योऽर्कः स्यात्पले तु विज्ञाते ।
नतपलधनुषोर्भेदः क्रान्तिधनुः स्याद्रवौ तु याम्यदिशि ॥ ५२ ॥
सौम्येऽर्के तद्योगः क्रान्तिधनुः क्रान्तितो रविः प्राग्वत् ।

[समशङ्कोरर्कानयनम्]

समशङ्कोः शङ्क्वग्रं तद्दिनाग्राऽतोऽपमोऽपमाच्चार्कः[5] ॥ ५३ ॥

योगविशेषवशात् शङ्क्वग्रलब्धिः । शङ्क्वग्रशङ्कुभ्यां प्राग्वत्स्वाहोरात्रेष्टज्या स्यात् । शङ्क्वग्रात् त्रिज्याघ्नात् स्वाहोरात्रेष्टज्यया लब्धमक्षज्या । अक्षतो लम्बकसिद्धिः । लम्बके विदिते क्रान्तितोऽर्काग्रासिद्धिः । पुनरप्येवं कृत्वा अविशेषयेत् । अविशिष्टाक्षज्या स्फुटतरा भवति ।

५२-५३a. मध्यच्छायातोऽप्यर्कः साध्य इत्याह—मध्यच्छायात इति ।

५३b. समशङ्कुतोऽप्यर्कः साध्य इत्याह—समशङ्कोरिति । समशङ्कोर्हि शङ्क्वग्रमर्काग्रा स्यात् ।

[1] A. बाहुर्भ्रग्राग्राज्यां (corrupt).

[2] All Mss. except G. omit च.

[3] A. C. D. corrupt, षान्तव. [4] D. G. मध्ये.

[5] E. पमाच्चार्कः (corrupt).

[भूच्छायाया योजनकर्णानयनम]

[1]अर्काग्रतिदिशि [2]भूमेश्छाया दीर्घा [3]सदा च वृत्ता स्यात् ।
मूले [4]भूसमपरिधिर्गोपुच्छाग्रेण संमिता साग्रे ॥ ५४ ॥
बिम्बं ह्यर्कस्य महत्तस्य करा भूमिपरिधिगा भूमेः ।
श्रुतिरूपेण समन्तात् [5]पतन्त्यतोऽल्पा क्रमेण सा छाया ॥ ५५ ॥
भूव्यासार्धोनरविव्यासार्धं[6] शङ्कुरस्य[7] रविकर्णः ।
छाया, भूदलशङ्कोः केति तदा दैर्घ्यमपि तमसः स्यात् ॥ ५६ ॥
इन्दोः श्रुत्या हीनं भूव्यासघ्नं हरेत्तमोदैर्घ्यम् ।
छायादैर्घ्येण फलं चन्द्रस्थाने तमोव्यासः ॥ ५७ ॥

५४. भूच्छायारूपमाह—अर्काग्रतीति ।

५५. मूलात् क्रमेण हीनव्यासत्वस्य हेतुमाह—बिम्बं हीति । भूपरिधौ पतितः अर्ककरा भूमेः समन्तात् श्रुतिरूपेण पतन्ति । परस्परं क्रमादासन्ना भवन्ति । तस्मात् छायाव्यासस्य क्रमाद्धीनत्वं भवति ।

५६. प्रदीपच्छायातुल्यया छायादैर्घ्यानयनमाह—भूव्यासेति । भूव्यासार्धोनं यत् रविव्यासार्धं तच्छङ्कुः, शङ्कुनदीपोन्नतिरित्यर्थः । रवेर्योजनकर्णस्तस्य शङ्कोश्छाया, शङ्कुप्रदीपान्तरालभूमिरित्यर्थः । भूव्यासार्धमिष्टशङ्कुः । यदि भूव्यासार्धोनरविव्यासार्धशङ्कोः रवेर्योजनकर्णतुल्या छाया, तदा भूव्यासार्धशङ्कोः केति भूच्छायादैर्घ्यलब्धिः ।

५७. इन्दुकक्ष्याप्रदेशे भूच्छायाया व्यासप्रमाणानयनमाह—इन्दोः श्रुत्येति ।

[1] The Mss. read only अर्कप्रतिदिशि ; G. has अर्के ; the emendation is in accordance with the commentary.

[2] A. C. D. भूम्योः (wrong).

[3] D. पदा ; A. C. सदा प्रवृत्ता.

[4] G. only has भू.

[5] E. तप.

[6] All Mss. except E. omit the *anusvāra*.

[7] A. C. E. F. रस्य omitted by haplography.

छायाग्रात्तद्दैर्घ्यान्तरे[1] यदि [2]क्षितिसमस्तमोव्यासः ।
इन्दोः श्रुत्यूनतमोदैर्घ्यान्तरे कस्तदेति युक्तिरिह ॥ ५८ ॥

[बिम्बकलाव्यासानयनम्]

योजनबिम्बं योजनकर्णे, त्रिगुणमिति कलाकर्णे ।
कियदिति लिप्ताबिम्बं तमसः शशिनश्च भानोः स्यात् ॥ ५९ ॥

[रविशशिग्रहणयोर्भेदः]

स्वाधःस्थितेन्दुना [3]यच्छादनमर्कस्य भवति तद् ग्रहणम् ।
प्रतिदेशमतो भिन्नं छादितमानं रवेस्तथा कालः ॥ ६० ॥
तमसि प्रवेश इन्दोर्ग्रहणं [4]स्व(? स्यात्)तुल्यमेव सर्वेषु ।
देशेषु, ततश्छादितमानं चन्द्रस्य भवति कालोऽपि ॥ ६१ ॥

[लम्बनयोजनानयनम्]

रविशशिनावेककलास्थावपि भूपृष्ठसंस्थितैर्मनुजैः ।
ऊर्ध्वाधःस्थौ प्राच्यां पश्चिमदिशि च प्रदृश्येते ॥ ६२ ॥

५८. तत्त्रैराशिकमाह—छायाग्रादिति ।

५९. सूर्येन्दुतमसां बिम्बलिप्तानयने त्रैराशिकमाह—योजनबिम्बमिति ।

६०. सूर्यग्रहणस्य स्वरूपमाह—स्वाध इति ।

६१. चन्द्रग्रहणस्य स्वरूपमाह—तमसीति ।

६२. रविशशियोगे दृग्भेदः संभवतीत्याह—रविशशिनोरिति ।

[1] Mss. have only दै for द्दै.

[2] A. C. D. E. क्षितितमा.

[3] G. यत् left out.

[4] G. स्व left out.

भूमध्यं ग्रहकक्ष्यामध्यं, दृक्ष्या कुपृष्ठगश्च यतः ।
तत्र तयोर्यद्विवरं तद्धि तयोर्लम्बनान्तरमितं स्यात् ॥ ६३ ॥
दृङ्मण्डलं तु विहगाभिमुखं [1]दृक्पृष्ठमध्यमिह भवति ।
[2]दृक्क्षेपर्क्षाभिमुखं तद्वद् दृक्क्षेपमण्डलं प्रोक्तम् ॥ ६४ ॥
क्षितिजं भूपृष्ठसमं दृङ्मण्डलमध्यगं कुपृष्ठे स्यात् ।
तत्क्षितिजेऽर्के शङ्कुः शून्यस्त्रिज्यामितः खमध्यगते ॥ ६५ ॥
एवं कुपृष्ठशङ्कुः, [3]कुमध्यशङ्कुर्हि गणितसिद्धः स्यात् ।
भूपृष्ठमध्यशङ्क्वोर्विवरं खेटस्य लम्बनं गदितम् ॥ ६६ ॥
योजनशङ्क्वोर्विवरं भूव्यासार्धेन तुलितमुदये स्यात् ।
शून्यं खमध्यगेऽर्के तस्माद् [4]दृग्ज्यावशात् कल्प्यं तत ॥ ६७ ॥

६३. दृग्भेदे हेतुमाह—भूमध्यमिति । ग्रहकक्ष्यादृङ्मण्डलयोर्भेदात् दृग्भेदः स्यादित्यर्थः ग्रहयोर्लम्बनकलान्तरतुल्यो दृग्भेद इत्याह—तत्रेति ।

६४. दृङ्मण्डलस्य दृक्क्षेपमण्डलस्य च संस्थानमाह—दृङ्मण्डलं त्विति । दृङ्मण्डलं दृक्क्षेपमण्डलं च भूपृष्ठमध्यमित्यर्थः । ग्रहकक्ष्या तु भूमध्यमध्या, इति भेदः ।

६५a. कुपृष्ठे क्षितिजमाह—क्षितिजं भूपृष्ठेति ।

६५b-६६a. दृङ्मण्डलगतभूपृष्ठशङ्कोरुत्पत्तिमाह—तत्क्षितिजे इति । गणितानीतः शङ्कुर्मध्यगतः स्यात् । तस्य दृग्ज्यायाः त्रैराशिकात् शङ्क्वोरन्तरं वेद्यम् ।

६६b. ग्रहस्य लम्बनस्वरूपमाह—भूपृष्ठमध्येति । भूपृष्ठे यः शङ्कुः भूमध्ये च यस्तयोश्चापितयोर्विवरं ग्रहस्य लम्बनं लिप्तात्मकं भवति ।

६७. शङ्क्वन्तरस्य त्रैराशिकसाध्यत्वमाह—योजनेति ।

[1] Mss. read दृक्. [2] A. C. D. दृक्क्षेपार्काभिमुखं.

[3] D. कुमध्य left out by haplography; G. कुमध्य (corrupt).

[4] B. दृग् left out.

भूव्यासार्धमितं चेत् त्रिगुणेन तदेष्टदृग्ज्यया तु कियत् ।
इति खगकक्ष्यायां तु [1]स्याद्विवरं शङ्कोस्तु योजनात्मकयोः ॥६८॥

एककलास्थखगानां सर्वेषां लम्बयोजनं तुलितम् ।
लम्बनलिप्ता भिन्नाः [2]कक्ष्याभेदात्तथापि सर्वेषाम् ॥ ६९ ॥
लम्बनलिप्ताविवरं यत्तत्तुलितं [3]तु खेटयोर्विवरम् ।
कक्ष्याल्पत्वादधिकाः शीघ्रगतेर्लम्बनकलाः स्युः ॥ ७० ॥

[लम्बनसंज्ञा]

हीनः कुपृष्ठशङ्कुर्दृङ्मण्डलतो[4] यतोऽत्र कक्ष्यास्थात् ।
शङ्कोर्लम्बनसंज्ञा शङ्कोर्विवरस्य कथ्यते तस्मात् ॥ ७१ ॥

[लम्बननत्योरानयनम]

कर्णात्मकमिदमुक्तं लम्बनमस्यैव बाहुभागभवम् ।

६८. ग्रहकक्ष्यागतशङ्कोर्विवरयोजनानयने [5]त्रैराशिकमाह—भूव्यासार्धमितमिति ।

६९. एकत्र गतानां ग्रहाणां लम्बनयोजनानि तुल्यानि स्युः। तेषां लम्बनकला भिन्ना एवेत्याह—एककलेति ।

७०. [6]ग्रहयोर्लम्बनलिप्तान्तरतुल्यं व्योम्नि दृश्यमानान्तरयोरेककलास्थयोर्विवरमित्याह—लम्बनलिप्तेति ।

७१. ग्रहयोर्विवरस्य लम्बनसंज्ञायां हेतुमाह—हीन इति । भूमध्यात्, भूमध्यनिरीक्षितग्रहात्, भूपृष्ठग्रहस्याधोगतत्वादित्यर्थः ।

७२-७३. शङ्कोरन्तरजातमिदं लम्बनं कर्णात्मकं स्यात् । अस्य

[1] E. स्यात् left out. [2] E. कक्ष्या left out. [3] G. हि.
[4] A. B. C. E. मण्डलगो. [5] A. adds तत् before त्रै.
[6] A. This sentence is left out by haplography.

संस्क्रियते पर्वान्ते [illegible] कोटिभागभवा ॥ ७२ ॥
दृग्ज्याश्रुतेर्हि कोटिदृक्क्षेपा दृग्गतिर्भुजा तस्याः ।
नतिलम्बने च ताभ्यां ग्रहणे भानोरतः [1]प्रसाध्येते ॥ ७३ ॥

[लम्बननत्योः विपरिणामः]

[illegible]शशिनोः षष्टिघ्नं लम्बनलिप्तान्तरं कलाभुक्त्योः ।
[illegible] हरेल्लब्धं घटिकाख्यं लम्बनं विनिर्दिष्टम् ॥ ७४ ॥
स्फुटयोजनकर्णे चेदियत्कियत्स्यात्तदा कलाकर्णे[2] ।
इति लम्बनलिप्ताभिः त्रिज्यातुलितो हि लिप्तिकाकर्णः ॥ ७५ ॥
[illegible] दृक्क्षेपज्या स्याद् दृक्क्षेपलग्नगे खेटे ।
दृक्क्षेपसिद्धलम्बनमेव नतिः सर्वदापि खेटस्य ॥ ७६ ॥

[illegible] [illegible]भागादुत्पन्नं लिप्तात्मकं लम्बनं ग्रहस्य नतिर्भवतीत्याह—
[illegible]मिति । कर्णात्मकस्य लम्बनस्य साधनं दृग्ज्या स्यात् ।
[illegible]र्णस्य भुजा दृग्गतिज्या । दृक्क्षेपज्या कोटिः । अतो [दृग्गति] दृक्क्षेपज्याभ्यां [3]लम्बनघटिनतिकले साध्येते इत्याह ।

७०. दृग्ज्याश्रुतेः(?) लम्बनघटिकानयनमाह—[illegible]शशिनोरिति ।

७५. लम्बनलिप्तानयने त्रैराशिकमाह—स्फुटयोजनेति । सर्वास्वपि [illegible] लिप्तिकाकर्णः त्रिज्यातुलितः स्यात् ।

[illegible]लग्नगे [4]खेटे [illegible] दृग्ज्या सा दृक्क्षेपज्या स्यात् । [illegible]दृग्ज्यातः सिद्धा लम्बनकलैव नतिः स्यादित्याह— दृग्ज्यैवेति ।

[1] [illegible] साध्येते.
[2] [illegible] common corruption [illegible]. [illegible] second letter [illegible] reviser [illegible] red off the vowel sign [illegible] to the [illegible]
[illegible] correct, दृक्स्थाक्षेपज्या.

वृत्ते [1]ह्यभीष्टदृग्ज्याकर्णे कोटिः सदापि दृक्क्षेपः ।
नतिसाधनं सदातो दृक्क्षेपज्यैव भवति खेटस्य ॥ ७७ ॥
भूमध्यपृष्ठशङ्कोर्मण्डलभेदाद्यथात्र[2] दृग्भेदः ।
मध्यस्फुटयोः कक्ष्याप्रतिमण्डलभेदतस्तथा भेदः ॥ ७८ ॥
लङ्कोदयप्रमाणानयने[3] विधिर्विलिख्यतेऽजादेः[4] ।
क्षेत्रे दोर्ज्या कर्णोऽत्रेष्टद्युज्या भुजापमः कोटिः ॥ ७९ ॥
त्रिज्याकर्णस्य भुजा परमद्युज्या यदीष्टकर्णस्य ।

दृक्क्षेपलग्नादन्यतः स्थितस्य खेटस्य दृक्क्षेपज्यावशात् कथं शङ्कोः नतिर्भवतीति शङ्कां परिहरति— वृत्ते ह्यभीष्टेति ।

७८. भूमध्यभूपृष्ठशङ्कोः यथात्र वृत्तभेदात् दृग्भेदः संभवति, तथा मध्यमस्फुटयोरपि कक्ष्याभेदाद् भेदो भवतीति स्फुटयुक्तिं संक्षेपेण प्रदर्शयति— भूमध्येति । भूमध्यमध्यायां कक्ष्यायां मध्यमचारः, ततो भिन्नकक्ष्यायां स्फुटचारः[5], तस्मादित्यर्थः ।

[लग्नानयनम्]

७९. लङ्कोदयप्रमाणानयनाय त्रैराशिकसिद्ध्यर्थं तदादिता(? श्रितं) क्षेत्रस्वरूपं प्रदर्शयति—लङ्कोदयेति । तस्मिन् क्षेत्रे इष्टभुजाज्या कर्णः स्यात् । दोर्ज्यान्तगतद्युमण्डले[6] इष्टज्या बाहुः इष्टक्रान्तिः कोटिः । एतदुक्तं भवति—पूर्वापरस्वस्तिकयोरुन्मण्डलास्त[7] [8]प्राप्तिकाले अपमण्डलगतेष्टभुजान्ताद् उन्मण्डलास्तापमण्डलज्या कर्णः । तद्भुजान्तात्तद्गतद्युवृत्ते उन्मण्डलान्ता द्युज्या भुजा । तद्द्युवृत्तपूर्वापरस्वस्तिकयोरन्तराले उन्मण्डलगता क्रान्तिज्या कोटिरिति ।

८०-८१. तत्त्रैराशिकमाह—त्रिज्येति । त्रिज्यातुलितदोर्ज्याकर्णस्य

[1] G. ह्य for ह्य.
[2] D. G. यतोऽत्र.
[3] D. G. नेऽपि.
[4] E. जादौ
[5] Mss. corrupt. A. चारित; B. चारंस्त.
[6] A. extra ति here.
[7] A. अस्त omitted.
[8] B. प्राप्त.

दोर्ज्यामितस्य केति स्वाहोरात्रेष्टजीवका भवति ॥ ८० ॥
इयती यदि द्युवृत्ते त्रिज्यावृत्ते[1] तदा कियती ।
इति कालज्या, तद्धनुरसवो बाहूदये निरक्षे स्युः ॥ ८१ ॥
[a]शशिकृतशशिरामघ्ना द्युज्यासदलोद्धृतेष्टबाहुज्या ।
चापीकृता निरक्षे बाहोरुदयासवोऽत्र हीत्युक्तम् ॥ ८२ ॥
[2]इष्टर्क्षस्याद्यन्तप्रमाणभेदो ह्यभीष्टराशिमितिः ।
स्वचरार्धोनयुता[3] सा मृगकर्क्याद्योः [4]स्वदेशराशिमितिः ॥ ८३ ॥
उदगुन्नतं भगोलं तस्माच्छीघ्रं मृगादिका यान्ति ।
उदयं शनैस्तु कर्कटकाद्यास्तस्माच्चरार्धविधिरेवम् ॥ ८४ ॥

परमद्युज्या हि भुजा । तदेष्टदोर्ज्यातुलितकर्णस्य का भुजेतीष्टद्युज्यालब्धिः । यदीष्टवृत्ते इयती ज्या तदा व्यासार्धमण्डले कियतीति घटिकामण्डलज्यालब्धिः । तच्चापलिप्ताः असवो भवन्ति । निरक्षदेशे इष्टबाहुभागस्योदयासवस्ते स्युः ।

८२. एवं ह्यत्रोक्तमित्यनुवादरूपेणैतत्कर्म च प्रदर्शयति—**शशिकृतेति**। त्रिज्यात्रैकत्र हारः । स एवान्यत्र गुणकारः । ततस्ताभ्यां विना कर्म क्रियते । भुजाभागस्योदयप्रमाणं ह्यत्रोक्तम् ।

८३a. इष्टराशिप्रमाणानयने पुनर्विशेषमाह—**इष्टर्क्षस्येति** ।

८३b. चरदलसंस्कारेण स्वदेशोदयमानानयनमाह—**स्वचरार्धेति** ।

८४. मृगादौ चरदलशोधनस्य, कर्क्यादौ तत्क्षेपणस्य च हेतुं प्रदर्शयति—**उदगुन्नतमिति** । क्षितिजस्य उदङ्नीचत्वादुदगन्ताः **शीघ्रम्**, अन्ये राशयः शनैरित्यर्थः ।

[1] E. त्रिज्यावृत्ते omitted by haplography.

[2] A. C. common corruption; A. इष्टस्यान्त; C. इ, then gap; G. इष्टक्षस्याद्यन्त. [3] G. मिता. [4] D. चोस्य.

[a] शशाख्यादि 3141.

[अयनचलनम्]

अयनचलनस्य[1] मानज्ञानाय विलिख्यतेऽथ चोपायः ।
छायाप्रसाधितो यः सूर्यस्तत्कालगणितसिद्धश्च ॥ ८५ ॥
योऽर्कस्तयोस्तु विवरं तत्काले प्रोच्यतेऽयनचलनमिति ।
भवति च यस्मिन् काले याम्योदग्गतिनिवृत्तिरर्कस्य ॥ ८६ ॥
अयनान्तस्य च तत्कालेऽर्कस्य च विवरमयनचलनं स्यात् ।
शङ्कुं कृत्वात्युन्नतमचल[2]स्तम्भादिकं प्रभां तस्य ॥ ८७ ॥
ईक्षेत गमनकाले चागमकाले च गणितविद् भानोः ।
अर्कस्य गमनकाले यस्मिन् काले त्वभीष्टबिन्दुगतम् ॥ ८८ ॥
छायाग्रमागमेऽपि च तद्बिन्दुगतं यदा प्रभाग्रं स्यात् ।
[3]तत्कालद्वयभवयोः [4]स्फुटभान्वोर्योगदलसमोऽर्कः स्यात् ॥ ८९ ॥

८५-८६a. अथ तत्कालेऽयनचलनज्ञानोपायमाह—अयनचलनस्येति । छायाप्रसाधितः सममण्डलच्छायया मध्यच्छायया वा प्रसाधितः ।

८६b-८७a. प्रकारान्तरेण चाह—भवति चेति । तत्काले, अर्कस्य याम्यगतिनिवृत्तिकाले, साधितस्य वा उदग्गतिनिवृत्तिकाले साधितस्य वार्कस्य, अयनान्तस्य, राशिनवकस्य राशित्रयस्य वा ।

८७b-९०. याम्योदग्गतिनिवृत्तिकालज्ञानोपायमाह—शङ्कुमिति । अत्युन्नतं दीपस्तम्भं ध्वजस्तम्भं वा देवालयोर्ध्वभागस्थापितबालकूटं वा भूमौ स्थापितवेण्वादि वा शङ्कुमिति प्रकल्प्य तस्य छायामीक्षेत । अचलं, सदा स्थिरं, दीपस्तम्भादि तस्येत्यर्थः । भानोर्गमनकाले, पूर्वापरसूत्रमतिक्रम्य दक्षिणां दिशं प्रति, उत्तरां दिशं प्रति वा गमनकाले छायामीक्षेत । तथा भानोरागमनकाले पूर्वापरसूत्रं प्रत्यागमनकाले च छायामीक्षेत । भूमौ दक्षिणोत्तरां कांचिद्रेखां विलिख्य तस्यां स्थितं छायाग्रमीक्षेतेत्यर्थः । गमनकाले यदा रेखायां छायाग्रं भवति तस्मिन् काले तच्छायाग्रे बिन्दुं कुर्यात् । तत्काले

[1] G. स्य omitted. [2] G. लं for ल. [3] F. reads तत्कालस्फुटद्वय.
[4] All Mss. other than F. corrupt; G. has भासोः for भान्वोः.

यस्मिन् काले तस्मिन् काले हि गतिनिवृत्तिरर्कस्य ।
ऋणमथवा धनमिति च प्रकल्प्यते तद्धि [1]गणितयुक्तिविदा ॥ ९० ॥

[ग्रन्थोपसंहारः]

समरेखायाः पश्चादष्टादशयोजनान्तरे[2] ग्रामे ।
[a]स्वरकृतषट्तुलिताक्षे वसता शाकेऽ[b]क्षषट्त्रिचन्द्रमिते ॥ ९१ ॥
परमेश्वरनाम्नेयं वदनभुवा **गोलदीपिका** रचिता ।
तिष्ठतु गणकवराणां द्विजमुख्यानां [3]हृदालये सुचिरम् ॥ ९२ ॥

इति गोलदीपिकायां चतुर्थोऽध्यायः

गोलदीपिका समाप्ता

स्फुटार्कं च कुत्रचित् स्थापयेत् । पुनरागमनकाले च यस्मिन् काले तस्मिन्नेव बिन्दौ तच्छायाग्रं भवति, तत्काले गणितसिद्धं स्फुटार्कं च कुत्रचित् स्थापयेत् । एवं स्थापितयोरर्कयोर्योगस्य दलं यत् तेन तुल्यः स्फुटार्को यस्मिन् काले भवति, तस्मिन् काले अयननिवृत्तिर्भवेत् । यद्यागमनकाले पूर्वबिन्दौ छायाग्रं न संभवति, तथापि तद्दिने पूर्वदिने परदिने च तस्यां रेखायां छायाग्रस्य स्थितिं ज्ञात्वा तदन्तरवशात् छायाग्रस्य पूर्वबिन्दौ [4]प्रवेशकालः कल्प्यः । यद्यवनान्तगतार्कात् प्रागेव याम्योत्तरगतिनिवृत्तिस्तदायनचलनं धनं स्यात् । अन्यथा ऋणं स्यात् । एतद् युक्त्या सिध्यति ।

९१-९२. अथ स्वाश्रितदेशं तत्काले शककालं च प्रदर्शयन्नुपसंहरति —समरेखाया इति ।

इति गोलदीपिकाविवृतिः[5] समाप्ता

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[1] A. B. C. E. गणक

[2] F. breaks off here.

[3] A. C. common corruption, ग for ह.

[4] B. प्रवेशः कालः.

[5] A. वृत्तिः.

[a] स्वरेत्यादि 647.

[b] अक्षेत्यादि 1365.

CHAPTER I

Introduction

1. I bow to Vināyaka (the Lord of Obstacles), the elephant-faced child, sitting on the lap of Pārvatī (daughter of the mountain), at the foot of the Kalpa (all-giving) tree and absorbed in suckling at her breast.

2. Parameśvara, the Bhārgava (of Bhṛgu's *gotra*), residing on the sea coast on the northern bank of the Nilā river,[1] sets forth in brief the nature of spherical astronomy for the benefit of the young.

Construction of the armillary sphere

3a. A circle[2] kept [vertically, and therefore] extending from below upwards, [and placed] in the north-south direction is [to represent] the Solstitial Colure (*Dakṣiṇottara*).

3b. Another [similar] vertical circle [fixed] at the [upper and lower] middle [points] of the first, [and turned to] the east-west direction, is the Equinoctial or Celestial Equator (*Ghaṭikā-maṇḍala*).

4a. Still another circle [*viz.*, the Equinoctial Colure] is [fixed] around these, cutting them at right

[1] This river is well known locally as Bhāratappuzha and flows through central Kerala, falling into the Arabian Sea a little to the south of Calicut (Kozhikode).

[2] The commentator says that the circle is to be constructed with bamboo strips, etc.

angles and making crosses (*Svastika-s*)[1] at the four cardinal points.

4b. These three are called *Viṣuvad* circles.

4b-5a. Of these the Celestial Equator is divided into 60 equal divisions, and the other two into 360 divisions.

5a-6a. Another similar circle is fixed passing through the east and west crosses and inclined at 24° north and south of the zenith and nadir. This is the Ecliptic (*Apama-vṛtta*).

6b-7a. Construct across the Solstitial Colure on either side of the Celestial Equator, (*Ghaṭikāvṛtta*) and parallel to it, at the required declinations, several diurnal circles (*Ahorātra-vṛtta-s*), of different magnitudes.

7b-8a. The orbits of the Moon and other [Planets] are [then to be constructed] crossing the Ecliptic at the Planets' two nodes [*Pāta-s*] and diverging from it [north and south] by their maximum latitudes at three Signs [i.e., 90°] from these nodes.

8b. Through the north and south crosses formed by the intersection of the Equinoctial and the Solstitial Colures, the central axis [of the armillary sphere] is then inserted.

9a. The sphere thus formed is called the Starry sphere (*Nakṣatra-gola* or *Bha-gola*).

9a-10a. The Celestial sphere (*Kha-gola*) is constructed outside this.[2] Herein too, [three circles

[1] The four cardinal points and the zenith and the nadir are called the six *Svastika-s* on the globe.

[2] An inner Starry sphere and an outer Celestial sphere are conceived in the armillary sphere according to Indian astronomy

corresponding to] the *Viṣuvad* circles [are to be constructed] as before. Of these the horizontal circle is [termed] the Horizon (*Kṣitija*); the east-west circle is [termed] the Prime Vertical (*Sama-maṇḍala*); and the third is the north-south circle or Meridian (*Dakṣiṇottara*).

10b. A [model] Earth is [then] to be constructed with clay, etc., in the shape of a sphere, and placed at the centre of [the axis of] the armillary sphere.

11a. The situation of the armillary sphere is like this at places of zero-latitude.

11a-12a. At any other required place, however, two holes are made in the Celestial sphere at a distance equal to the latitude [of the place],[1] below and above, respectively, the south or north crosses and the axis of the Starry sphere is made to pass through them.

12b-13a. A circle termed *Unmaṇḍala* is now constructed [and fixed] so as to pass through the two ends of the axis and the east and west crosses. This will be the situation of the spheres at the desired place.

13b. Two pieces of reed (*śara-daṇḍikā-s*) are fitted [on the axis] between the two spheres to keep them in position.

14. The Starry sphere revolves constantly westwards, blown by the Pravaha wind. The Celestial sphere, however, remains stationary; it is constructed in order to reckon directions, etc.

to facilitate comparative measurements of the former with reference to the latter. See below, verse 14.

[1] *Pala-jyā*, here, as also elsewhere below, means only the latitude, *akṣa*, and not sine latitude, *akṣa-jyā*.

15. To measure the sine and cosine of the latitude, some construct a diurnal circle [with a radius equal to the sine latitude, *akṣa-jyā*,], with [a point on] the central axis as the centre and just touching the horizon. Here the ***Bhū-jyā*** (i.e., sin. decl. tan. lat.) is sine latitude and the sine declination is cosine latitude.

Thus, in *The Light of Spherical Astronomy*,
is the First Chapter entitled
"Construction of the Armillary Sphere"

CHAPTER II

Diurnal motion of Planets

1. The Sun is constantly moving eastwards along the Ecliptic; still on account of the more rapid [westward] rotation of the [Starry] sphere [of which it also forms a part], it [appears] to move westwards.

2. The Starry sphere, impelled by the Pravaha wind, keeps rotating westwards round the Earth in the *pradakṣiṇa* (clockwise) direction once in 60 *ghaṭikā-s*

3. Above the surface of the Earth, at a height equal to 12 *yojana-s*, the Pravaha wind blows with a constant westward motion. Below it (i.e., up to a height of 12 *yojana-s*) is the terrestrial wind; [the direction of] its motion is diverse.

4. By *ghaṭikā* (or *nāḍikā*), is meant the time required for the rotation [of the Celestial Equator] through its one-sixtieth part, and not one-sixtieth of

the duration of a [Sāvana] day,[1] for the day is [a little] longer[2] than the time of rotation of the [Starry] sphere.[3]

5. The horizon is the horizontal circle around the Earth. Planets become visible when they rise above it. Planets below it are not seen, being hidden by the body of the Earth.

6a. Thus is it said in the ancient texts.

6a-b. [However,] only those Planets which rise above [the level of] the Earth's surface [*viz.*, the visual or sensible horizon] are seen by us; and those below [the level of] the Earth's surface are not visible.[4]

7-8a. Since the Sun is on the Ecliptic [which is inclined to the Celestial Equator], it rises [a little] to the north or south [of the central point, *viz.*, due east] according to its position; it also sets accordingly.[5] The Moon and other [Planets] move further north or south than the Ecliptic due to their Celestial latitude (*vikṣepa*).

8b. In places having [north] latitude [i.e., north of the terrestrial equator], the Planets reach the centre

[1] The Sāvana day is from sunrise to sunrise.

[2] The difference between a Sāvana day and a Nākṣatra day is about 10 *vināḍikā-s* or 4 minutes.

[3] That is called the Siderial (Nākṣatra) day.

[4] The difference in the position of Planets viewed from the surface of the Earth and from the centre of the Earth is termed *Lambana* or Parallax. See below, Ch. IV.

[5] The angle subtended by the east or west point and the point of rising or setting, respectively, is called the amplitude. See below, verse 14.

of the heavens [*viz.*, the Celestial Meridian] at a more southerly position than at their rising.[1]

9. The Sun on the eastern *Unmaṇḍala* reaches the western *Unmaṇḍala* in 30 *nāḍikā-s*, and from there in an equal length of time it reaches the eastern [*Unmaṇḍala*].

10. Here by *ghaṭikā* (*nāḍikā*) is meant one-sixtieth of the [Sāvana] day. This will be its connotation elsewhere than in the case of the rotation of the Starry sphere.

11-12. Rising and setting take place on the horizon. In the northern [hemisphere] the horizon is below the *Unmaṇḍala*. Hence [when the Sun is] in the northern hemisphere, the day will be more than 30 *ghaṭikā-s*. In the southern [hemisphere] the horizon is above the *Unmaṇḍala*; and so, here, the day is less than 30 *ghaṭikā-s*. At all places, as the day increases, night becomes shorter, and as it shortens, the night grows longer.

13. At places of zero-latitude [i.e., on the equator], the day is [always] 30 *ghaṭikā-s*, and so also the night, since there the *Unmaṇḍala* itself is the horizon.

Definition of Sine Amplitude, etc.

14a. Sine Amplitude (*Arkāgrā*) is the distance in the shape of the sine of the point from where the Sun

[1] This is generally known as 'Southing'. For places south of the equator, however, the deflection will be to the north. This phenomenon for the southern hemisphere is not envisaged by Indian astronomers and hence 'Northing' is not separately described here.

touches the horizon [i.e., points of rising and setting] to the east-west line.[1]

14b. The *Astodaya-sūtra* or the line of rising and setting, is the east-west line joining the two points [of rising and setting, respectively].

15-16a. Sine Declination (*Krāntijyā*) is the sine of the [angular] distance between the point where the Sun touches the *Unmaṇḍala* and the east or west point (*Svastika*). Let this be the *Bhujā* (altitude). Let the radius of the diurnal circle on which the Sun is, *viz.*, cos. declination (*Dyu-dala*) be the *Koṭi* (base); the radius of the sphere will [then] be the hypotenuse (*Karṇa*) of this right-angled triangle.

16b. The circle along which the position of the Sun moves is called the Diurnal Circle (*Dyuvṛtta*).

17. The sine of the [arc of the] diurnal circle between the horizon and the *Unmaṇḍala* is called *Kṣitijyā*. Let it be the *Bhujā*. Let sine declination be the *Koṭi* here. Then sine amplitude will be the hypotenuse; these three make a [right-angled] triangle.

The true eastward motion of Planets

18-19. The Sun on the Celestial Equator at Laṅkā moves in the heavens westwards along the Prime Vertical, and so also at all places on zero-latitude.

[1] This angle of amplitude is subtended at the centre of the Earth (or the Earth's surface, which makes little difference) by the point of rising or setting and the east or west point respectively. At the equator it is equal to the declination and at other places it is a function of the declination and the latitude of the place: sine amplitude = sin. decl. sec. lat.

The same [Equinoctial] Sun moves around along the horizon at Meru. At other places it moves between the zenith and the horizon according to the latitude [of the place].

20-21. The stars are stationary. Below them are, in order, Saturn, Jupiter, Mars, the Sun, Venus, Mercury and the Moon, all moving eastwards by their individual motion, and westwards with reference to [places on zero-latitude, like] Laṅkā, due to the rotation of the entire Starry sphere, in the same manner as insects on a potter's wheel moving in a direction opposite [to that of the wheel].

22. The [distance in] *yojana-s* covered per day by all Planets, whether high or low, [i.e., distant or near] in their easterly motion is the same. But their motion in terms of minutes of arc is diverse.

23-24. The orbit of a Planet which is low down is small and that of one high up is great. The number of minutes, degrees and Signs is the same in both small and big circles. Moving along a smaller circle, a Planet completes its circle in a shorter time, and moving along a bigger circle [completes it only] in a longer period. Hence the number of minutes covered in a day varies [from one Planet to another].

[Objection]

25. All the Planets are seen moving only westwards. This being the case, by what reasoning is their easterly motion presumed?

[Answer]

26. The Moon [seen] in conjunction with the *Aśvinī* constellation, is seen the next day in [conjunction with] *Bharaṇī*.[1] Mars and other Planets also behave in the same way. Their easterly motion is determined from this.

[Objection]

27. The Moon is slow; Saturn moves fast; and the stars are faster still. All move westwards. [If we suppose thus, then also will they behave as stated in verse 26]. So argue some.

[Answer]

28. We assert, however, that this [explanation], too, is wrong, because a retrograde Planet in *Kṛttikā*[2] is seen a few days later in *Bharaṇī* which is to its west, and not in an easterly position.

Position of the Moon in relation to the Sun

29. In the statement of the sages that the Moon is above the Sun, it is not the visible Moon that is envisaged; there a distinct Moon-deity is to be presumed.[3]

[1] The *Aśvinī* constellation is called *Dasra*, because it is presided over by the Aśvins, also called *Dasrau*. *Bharaṇī* is called *Yāmya* because its presiding deity is Yama, the God of death.

[2] The God *Anala* (Fire) is the presiding deity of *Kṛttikā*.

[3] The reference is to Upanisadic statements like the description of the 'Path of the Gods' (*Devayāna*) in the *Chāndogya Upaniṣad*: *Ādityāc candramasam, candramaso vidyutam . . . Brahma gamayati. Eṣa devayānaḥ panthāḥ*, etc. (IV. 15. 5). Śaṅkara in his *Brahmasūtra-bhāṣya* IV. 3. 4 says that distinct deities are to be presumed in cases like these.

30. It is stated by those sage-authors of the Purāṇa-s that the stars are above the Planets; above them are the Seven Sages (the Great Bear), and above them the Pole.

31-32a. This is so only on Meru and so the composers of the Purāṇa-s were on Meru. At Meru when the Sun is at the [northern] extremity of the southern [hemisphere, i.e., on the horizon], the Moon near it, having a north-latitude (*uttara-vikṣepa*), is seen above the Sun. The above statement may perhaps be due to this [phenomenon].

32b-33a. [In fact] the Sun is hidden by the Moon at the end of the New Moon when it has no latitudinal deflection (*vikṣepa*), and hence it is definite that the Moon is below the Sun.

33b-34a. If the Moon is above the Sun, it would be seen almost full on account of the Sun's rays falling on it from below even on the thirteenth day of the dark fortnight.[1]

Brightness of the Moon

34b-35a. If brightness is presumed by anybody as inherent in the Moon, then, he will also have to state the reason for its increase and decrease.

35b-36a. At the end of the New Moon [i.e., conjunction], the rays of the Sun fall upon the upper

[1] The significance of taking the thirteenth day and not the fourteenth or the New Moon day itself is that on those days the Moon may not be visible due to the bright light of the Sun, and sometimes even be hidden by the Sun.

half of the Moon which is below it. The visible [lower] half [of the Moon] is therefore dark at that time [and hence not seen].

36a-37. When the Moon is to the east of the Sun, the rays of the Sun fall on its western side, and therefore the Moon is bright there. Thus occurs the gradual increase of the Moon's brightness, and fullness at the end of the Full Moon day. From then onwards [as the Moon moves to the west of the Sun] the darkness [of its western side] gradually increases due to the absence of the Sun's rays.

Cause of eclipses: Refutation of unscientific views

38. If it is presumed that Rāhu swallows the Sun or the Moon, how is it that the Sun or the Moon at the seventh Sign from it is also swallowed by Rāhu which is far from it?

39. If, however, two Rāhu-s are presumed at a distance of 6 Signs [from one another] how is it then that in the case of the Moon, the first contact (*sparśa*) is at its east and the last contact (*mokṣa*) at its west, and for the Sun it is the reverse [i.e., *sparśa* in the west and *mokṣa* in the east]? [1]

40. Again if the Sun is gripped in Rāhu's mouth, how does it appear sharp-horned, while the Moon in the same position appears blunt-horned?

[1] The idea is that if Rāhu swallows the Moon and the Sun, since their direction of motion is the same, *viz.*, eastwards, Rāhu should swallow them both in the same manner, i.e., from the east end, which is not actually the case.

The correct explanation

41. [Really] the Moon is the hiding object of the Sun, and of the Moon [the hiding object] is the huge shadow of the Earth. This shadow of the Earth will [always] be at the seventh Sign from the Sun, moving with a velocity equal to the Sun's.

42. In the case of the Moon, since the eclipsed object [*viz.*, the Moon] is faster, the beginning of the eclipse at the east, and the end at the west. In the case of the Sun's [eclipse], due to the slower motion of the eclipsed body [*viz.*, the Sun], these two [the beginning and end] are the other way.

43. The orb hiding the Sun [*viz.*, the projection ... Moon] is small and hence sharp horns ... iding the Moon [*viz.*, the Earth's shadow] is big and hence it is blunt-horned.

Or it ... at what was stated before ... verse 38] are cases of eclipses which are calamitous portents (*ut*... d not calculable, and Rāhu that said to cause it is the one spoken of in the

Thus there are statements of old like, "The ... vastṛ) darkens the Sun even without ... t time ... than] the New Moon such ... rence k

Sun, ...

46b-47. They appear to us in the shape of plane circular mirrors on account of their being at a [great] distance. If the orb of the Moon is like a plane circular mirror, when the Sun's rays fall on it, the phenomenon of a part alone being lighted cannot happen, since there is no obstruction.[1]

48. The Sun is a fiery orb with a radius of 4410 *yojana-s*. The radius of its orbit is equal to 459585 *yojana-s*.

49. The radius of the Moon is 315 *yojana-s* and its orb is watery.[2] The radius of its orbit is equal to 34377 *yojana-s*.

50. The rays of the Sun falling upon the watery surface of the Moon, [and being reflected thence] destroy the darkness of the night, just as the Sun's rays falling on the surface of a mirror [are reflected and] destroy the darkness inside a building.

Thus, in *The Light of Spherical Astronomy*,
is the Second Chapter entitled
"Discussion on the Movements of Planets"

[1] The idea is that if light falls on a plane mirror, the whole surface will be lighted, ill or well, whatever be its slope. Hence phases of the Moon which we actually see cannot occur if its surface is plane.

[2] *Āpyam* means *ap-mayam*, watery The conception is that the Sun's orb is fiery and that of the Moon watery, as that of the Earth is earthy.

CHAPTER III

The self-supporting Earth

1. The Earth, a regular sphere, with a diameter of 1050 *yojana*-s remains suspended in the centre of space by its own sustaining power.

2. Fire is not consumed by other things, but it consumes all; in the same manner the Earth is not borne by other things, but itself bears everything.

3. Some say that the Earth is supported by [the serpent] Ananta; others say [that it is borne] by the elephants of the [eight] quarters. In such [an explanation] a support for the support will have to be presumed, and thus there will be infinite regress.

Motion of the Earth refuted

4. In the opinion of others the Earth rotates eastwards [once] in a day. But if this be the case, how can birds which have gone out of their nests return back to their nests? [1]

5. Still others say that the Earth keeps on falling downwards since space is endless. If this be so how can a stone thrown into the air fall back on the Earth? [2]

[1] This is an objection raised and accepted by all Indian astronomers including Āryabhaṭa, Varāhamihira, Bhāskara, etc

[2] What is implied here is the theory of the ancients that heavier bodies fall faster than lighter bodies. In that case, how can a stone falling slowly reach the Earth which is falling faster ?

Size of the Earth

6. The circumference of the Earth is equal to 3299 *yojana-s*. This is determined by teachers of astronomy by the rule of three and by inference.[1]

7. What is given by Āryabhaṭa as the measure of the Earth and the distances [of the Planets from it], etc., is given as more than one and a half times by other [astronomers]; this is due to the difference in the measure of the *yojana* [adopted by them].[2]

Latitude in relation to the Pole-star

8a-9a. The Pole-star is [seen] at Laṅkā on the horizon [at the north point]; it will be right above at the centre of the heavens [as seen] from Meru. The Sun on the Celestial Equator will be at the centre of the heavens at midday at Laṅkā. The same Sun will be on the horizon [as seen] from Meru.

9b-10a. Hence as we go northwards from Laṅkā, we have to postulate the increase in the altitude of the Pole-star and the zenith distance of the midday Sun. This zenith distance of the Sun or altitude of the Pole-star will be equal to the latitude[3] at the place [of observation].

[1] Verses 8-11 constitute the inference for this, and 12-13, the method for its calculation.

[2] The *Sūryasiddhānta*, for instance, gives 1600 *yojana-s* as the Earth's diameter. It may be noted that Āryabhaṭa's *yojana* corresponds to about 8 miles and that of the *Sūryasiddhānta* to 5 miles.

[3] The term *Akṣajyā* here means only *Akṣa*, latitude, and not sine latitude. For similar use, see above I. 11, and also below.

10b-11. The latitude, zenith distance of the Sun and altitude of the Pole-star gradually increase [as one proceeds] towards the north. Hence from an increase in the latitude, northward displacement from Laṅkā has to be inferred; and in the same manner, by an increase in latitude from one's own place, northward displacement from that place [can also be inferred].

Calculation of the Earth's circumference

12-13. Having fixed upon two places situated exactly north and south, determine their latitudes[1] and the number of *yojana-s* between them. Then apply the rule of three: If the distance between the two places is caused by their difference in latitudes, how much [will the distance be] for the degrees in a circle [i.e., 360°]? The result will be the circumference of the Earth.

14. Or, if the difference in degrees of the two latitudes are the *yojana-s* between them, how many will the *yojana-s* be for 90° which is the latitude of Meru? This will give a quarter of the circumference of the Earth.

[*Measures given by others reconciled*]

15. Some say that the Earth is many lakhs of *yojana-s*, and others, several crores of *yojana-s*. In such cases we have to presume [that they are speaking of] different aspects [of the Earth].

[1] For the method of calculation of the latitude, see below.

16. Segments with the four sides equal to one *yojana* each [i.e., *yojana*-squares] on the Earth's surface will number several lakhs; hence [the area of the Earth in square *yojana-s*] is what some are talking about.

17. Bits of Earth made up of one *yojana* each in length, height and breadth [i.e., *yojana*-cubes] would be in crores; hence [the volume of the Earth in *yojana*-cubes] is what others are talking about.

18. Life exists everywhere, inside the Earth in the nether regions and on its surface; and hence to reckon in both these measures is [also] reasonable.

Geography of the Earth

19. The statement that the Seven Islands and the Seven Oceans are each, in order, double the extent of the previous, is taken by astronomers as given only for [religious] meditation (*upāsanā*), and not something to be verified by observation.

20. The upper [northern] hemisphere of the Earth is mostly land and the lower [southern] half is mostly water; and in the lower hemisphere are said to be all the islands and so also the oceans.

21. Due to the preponderance of water the lower half of the Earth is said to be water. In the same way the upper half is said to be land on account of the preponderance of land.

22. Heaven and Meru are at the centre of the land, and Hell and Baḍabāmukha are at the centre of the waters. Gods and demons respectively reside in these two places.

23. Meru has two extremities.[1] One projects beyond the centre of the land [*viz.*, through the North Pole], and the other [beyond] the centre of the waters [*viz.*, the South Pole]. [These two extremities] are occupied by the gods and the demons [respectively].

24a. Here the terms 'above' and 'below' have been used presuming the centre of the land [North Pole] as 'above'.

Fixing the directions

24b-25. The directions are fixed [differently] from place to place, and hence they vary. Where the rising of the [Equinoctial] Sun occurs, that is the east at that place. From that the other [directions are determined]. For everyone, [that part of] the surface of the Earth occupied by him is 'below', and from that 'above' [is reckoned].

The Pole-stars

26-27. Above the upper extremity of Meru is a star named Dhruva (Pole-star, Polaris). Below the lower extremity of Meru must also be another star called Dhruva [South Pole-star]. These two Pole-stars are, as it were, the extremities of the [central] axis supporting the [Celestial] sphere. Hence as seen from Meru the sphere [seems to] rotate around like a waist-band [of the Earth]; as seen from Laṅkā,

[1] The conception is that Meru extends through the centre of the Earth and projects out at the northern and southern poles of the Earth.

however, it [seems to] rotate passing overhead [from east to west].

The four cities at the cardinal points

28. The four cities in the ocean named Laṅkā, Romaka, Siddhapurī, and Yavakoṭi are to the south, west, north and east of Meru respectively.

29. Being on zero-latitude, there is no altitude to the Pole-star at these places, and hence no Equinoctial shadow either. The directions [of the four cities], as south, etc., from Meru are given above with reference to Laṅkā [which is taken as south].[1]

Height of Meru

30. By some the height of Meru is said to be 84,000 *yojana-s*. This is not acceptable to the astronomers; and the reason is stated below.

31-32. Where the Pole-star has [some] altitude, some stars will be seen by us north of the Pole-star [i.e., closer to the horizon than the Pole-star] and moving eastwards. If Meru is very high these will not be seen, being hidden by it [at the lowest part of their motion].[2] Hence it is [to be] presumed that Meru is not very high.

[1] The idea is that from Meru all directions are only south; the directions of Laṅkā, etc., are said to be south, west, etc., as they would appear so if Laṅkā is taken as south.

[2] The idea is that at places of higher latitudes we can see the circum-polar stars moving round the Pole-star. Here the upper transit is from east to west, and the lower transit, from west to east, and the latter still north of the Pole-star, i.e., nearer the

33. There is also [the following problem] posed:[1] "Tell the magnitude of the latitude at a place where the Sun at the end of the *Mithuna-rāśi* (summer solstice), [crimson] like molten gold, appears to touch the horizon on the sea, [but] does not set."

34-35a. Here by speaking of the similarity [of the Sun] to gold, it is also said that the Sun is touching the horizon. Sin. latitude in this problem is equal to 3141.[2] Hence if Meru were very high this phenomenon [*viz.*, the visibility of the Sun at the horizon] cannot happen.

35b. All statements made by the learned [sages] not sustainable by proof have to be taken as intended for meditation only.

Relativity of Up and Down

36. Everywhere on the surface of the Earth are living beings, vegetation, and water, "just as a cluster of Kadamba flowers is surrounded on all sides by flowers."[3]

horizon than the Pole-star. If Meru projected to a considerable distance beyond, that will hide the lower transit, at least at one point, near the horizon. It may also be noted that Āryabhaṭa gives the height of Meru as only one *yojana*; cf. *merur yojanamātraḥ* (Golapāda, 11).

[1] This is a quotation, an illustrative question posed for calculation of latitude, from Govindasvāmin's commentary on the *Mahābhāskarīya* of Bhāskara I, III. 53 (ed. Oriental Manuscripts Library, Madras p. 167).

[2] This corresponds to a latitude 66° North.

[3] The simile of the Kadamba flower is a quotation from the *Āryabhaṭīya*, Golapāda 7.

37. Whatever part of the Earth is seen, there that itself is seen as the topmost portion of the Earth, and hence living creatures reside everywhere.

38-39. The divine beings say, "We are at the top; the demons are at the bottom" and the demons say, "We are on the top, and the gods are at the bottom". [So say these two] who occupy the north and south. Persons occupying the east and west portions also speak in the same manner, because all have the feeling, "We are on the top of the Earth".

The Sun

40-41. At every instant [of the day] the rising of the Sun occurs in some place or other and also the setting. Similarly the different parts of the day and night. "The rising moment of the Sun at Laṅkā, is itself the moment of setting at Siddhapura, noon at Yavakoṭi, and midnight at the land of Romaka."[1]

42. When in the middle [of the sky, the Sun's] rays have intense heat there is also an illusion of colours caused by the falling of the rays. Therefore the same Sun appears different in different places due to [its varied] colour and degree of heat.

Day and night at the Poles

43. The gods [at the North Pole] have the six Signs commencing from *Meṣa* (Aries) [always] above the horizon, and hence the six months beginning with *Meṣa* is the day for the gods.

[1] This is also a quotation from the *Āryabhaṭīya*, Golapāda 12.

44. The six Signs beginning with *Tulā* (Libra) are [always] below the horizon for the gods, and hence the six months beginning with *Tulā* form the night for the gods.

45. The day and night of the gods are for the demons, night and day respectively, since for the gods and demons, the distinction between 'above' and 'below' is reversed.

46. From all places Meru and the ocean are in the north and south respectively. The direction of the rising of the Equinoctial Sun is east and from it the other [directions] [are to be determined].

47. North of zero-latitude, when the Sun is north [of the Equinoctial], daytime will be longer; when the Sun is south [of the Equinoctial], daytime is shorter. [The duration of] the night is the reverse in all cases.

48-49. In that place where sin. latitude is 3141, there daytime will be 60 *nāḍikā-s* and night absent when the Sun is at the end of *Mithuna* (Gemini) [i.e., summer solstice].[1] There, generally, by contiguity with the [previous or next] day, the daytime may be very nearly 120 *nāḍikā-s*. [At this place] when the Sun is at the end of *Dhanus* (Sagittarius) [i.e., winter solstice] night will extend to 60 *nāḍikā-s* and daytime will be zero.

50. At a place where cos. latitude (*Lamba-jyā*) is equal to the sin. declination of 2 Signs, there *Dhanus*

[1] See above, III. 34-35. This implies a maximum declination of the Sun of 24°.

and *Makara* (Capricorn) Signs do not rise at all; and the Signs of *Mithuna* and *Karki* (Cancer) do not set at all.[1]

51. Therefore only eight Signs can be Rising Signs (*Lagna*) at that place. The state of being *Lagna* does not happen to *Makara*, *Karki*, *Mithuna* and *Dhanus* because they do not touch the horizon at all.

52. At the place where the cos. latitude is equal to the sin. declination of one Sign,[2] there the four Signs commencing from *Vṛṣabha* (Taurus) do not set, and the four Signs from *Vṛścika* (Scorpio) do not rise.

53. There the four months commencing from *Vṛṣabha* will form a single day, [and the four months] from *Vṛścika* will be night.

In the previous case [verses 50-51] day and night are each two months.

54. In places where the cos. latitude is less than the sin. maximum declination (*Parama-apakrama-jyā*), the rising of some Signs will be backwards.[3] All this can be demonstrated on the [armillary] sphere.

[1] Taking the maximum declination to be 24°, the declination of the Sun at the end of 2 Signs is 20° 37'. So when the Sun is in *Mithuna* and *Karki*, it will have a declination greater than 20° 37', i.e., it will have a north-polar distance of less than 69° 23'. Now regions of the sky having a north-polar distance of 69° 23' and less will be circum-polar. Therefore the Sun will never set in these regions during this period.

[2] The declination at the end of one Sign is 11° 45' and hence the region envisaged in this verse would correspond to above 78° 15' latitude.

[3] This would be in places with a latitude higher than 66°. A formula for this negative rise of *Lagna* may be given here: $\sin\theta = \cos\phi + \sin\omega$, where θ is the *Lagna*, ϕ the latitude of the place and ω the maximum declination. $+\theta$ to $-\theta$ will be the region of negative rise of the Sign.

55. At the place of zero co-latitude [i.e., at the Poles] the six [Signs] beginning from *Meṣa* do not set and the six beginning from *Tulā* do not rise. At this place no Sign has *Lagnatva*.

56. All this enunciation has been made for the side of the gods [i.e., the northern hemisphere]. On the side of the demons [i.e., the southern hemisphere], however, the visible and non-visible [portions] are reversed. The *Lagnatva* for the Signs is, however, the same as on the side of the gods.

57. In regions where [the rising of] the Signs is peculiar [i.e., certain parts of the Signs not rising, certain parts not setting and certain parts having negative rise] the *Cara-saṃskāra*[1] [the correction for oblique ascension applied to the right ascension or *laṅkodaya-rāśimāna*] cannot be thought of, for there, with reference [to some or all] the six Signs beginning with *Makara* may each become zero [or negative, when *Cara-saṃskāra* is applied].

Measurement of the day of the gods, etc.

58. The manes [living] on the upper surface of the orb of the Moon see the Sun [continuously] for half a lunar month, men [on the Earth] for half a [solar] day and the gods and demons for half a solar year.

59. The Creator (Brahmā), however, sees the Sun, which is at a very great distance from Him continuously for a thousand æons (*yuga-s*); for an equal

[1] See below, IV. 79 ff.

period [of a thousand æons] the Creator does not see the Sun on account of the latter's absence.

60. Then after the lapse of a thousand æons, the day dawns for the Creator, then all the gods, etc., [including, of course, the Sun], are created. Again days, etc., [follow] as before.

61. A thousand and eight æons form the day of the Creator, so Āryabhaṭa has said; according to his view the night, too, is of equal measure.

Puranic description of the Earth

62. By Śrīpati have been described the Seven Islands, etc., on the terrestrial sphere. [Adapted] from that, something on this subject is given by me also for [the information of] the novice.

The Seven Islands and Oceans

63. Jambū, Plakṣa, Śālmala, Kuśa, Krauñca, Śāka and Puṣkara: these are in order the Seven Islands from the middle [region of the Earth].

64. These [islands] are surrounded respectively by the salt, cane-juice, spirituous liquor, ghee, curd, milk, and water oceans. The Jambū island occupies the upper half [i.e., northern hemisphere in entirety] and the other six [islands] are in the lower half [i.e., southern hemisphere].

The Jambū island and Meru

65. Meru is a golden mountain at the centre of the Jambū island and it stands like the

ovary at the centre of the lotus [in the form] of the Earth.

Divisions of the Jambū island

66-68a. In the Jambū island there are nine main divisions (*khaṇḍa-s*). Ilāvṛta is in the middle [i.e., near and around the North Pole]. [The divisions] named Bhārata, Kimpuruṣa and Harivarṣa are [north] from Laṅkā and south of Meru; to the north [of Meru] are Ramyaka and Hiraṇmaya; Kuruvarṣa is to the extreme north;[1] to the east is Bhadrāśva and to the west Ketumāla. Thus are set forth the nine divisions.

Mountains, trees, lakes, etc., in the Jambū island

68a-69a. Around Meru is Ilāvṛta. In it are four mountains known as Viṣkambha on the [four] sides of Meru; they are, in order from the east, Mandara, Sagandhamādana, Vipula and Supārśva.

69b-70a. On their peaks grow [respectively] the divine trees Kadamba, Jambū, Pippala, and Vaṭa, which are of huge size. The Jambū tree indeed gives the name of Jambū to the island.

70b. There are also the forests called Caitraratha, Gandhamādana, Vaibhrājaka and Nandana.

71-72a. On Meru are four lakes of the gods, named Aruṇoda, Sitoda, Mānasa and Mahāhrada, in order from the east. Thus is the central division (Ilāvṛta).

[1] This is with reference to Laṅkā and in a line from Laṅkā across the Pole. The location of this would therefore be exactly on the other side of the Earth, opposite Laṅkā.

72a-73a. In the other [divisions] there are eight boundary mountains, Himavān, Hemakūṭa and Niṣadha to the south of Meru [and beginning from the south], and similarly Nīla, Śveta, Śṛṅgī to its north. These [six] with Meru are the seven principal mountains (*kula-parvata-s*).

73b-75a. To the eastern side is Mālyavān, on the west, Gandhamādana, and around [Meru] in the place of the filaments [in the lotus flower] are mountains. To the east of Meru are Śītāmbhas and other [mountains], to the south, Trikūṭa, etc., to the north Śaṅkha-kūṭa and others, and to the west Śikhivāsas and others.

75a-76a. Now are enumerated the petals of the lotus called the Earth: Bhadrāśva, Bhārata, Ketumāla, and the Kuru [countries].

76a-b. Above Meru is the region of the Creator (Brahma-sabhā), and the cities of Indra and other [guardian deities of the quarters] are in the four cardinal directions and the [four] intermediate directions with reference to the position of the Creator.

Rivers of the Jambū island

77-78. The Gaṅgā rising from the foot of Viṣṇu flows through the City of the Creator (Vidhipurī). There, branching off into four, it flows in the [four] directions, east, etc., with the names Sītā, Alakanandā, Sucakṣus and Bhadrā. Flowing across the countries in those directions and crossing the mountains [in those regions] they reach the oceans.

79. The Alakanandā [flowing] south branches into seven in the Bhārata country. The flow of these [rivers] from one mountain to another is said to be through the higher regions.

Residents of the other divisions

80. Persons residing in the other eight divisions, Kimpuruṣa, etc., have no sorrows. Their span of life is twelve thousand years, or a little more or less.

81. There the [Rain-]God does not rain. All water there is from the Earth. The different æons *Kṛta*, *Tretā*, etc., too are not postulated with reference to them.

82-83. Fruit of the Plakṣa tree in Kimpuruṣa and sugar in Harivarṣa form the staple food; it is mangoes in Bhadrāśva, jack fruit in Ketumāla, the fruit of the Jambū tree in Ilāvṛta, the fruit of the Vaṭa tree in Ramyaka, the Likuca (bread-fruit) in Hiraṇmaya, and the sap of the Kalpa tree in the [land of the] Kuru-s.

The Land of Bhārata

[illegible] of Bhārata lies north of the ocean and [illegible] the Himālaya mountains. It is also [otherwise] stated to lie between the southern seas and Bindusaras.

85-86. This is the *karma-bhūmi* [the land of actions], for here alone exist spiritual merit and demerit (*puṇya* and *pāpa*). People of this land who do meritorious deeds attain to heaven, and sinners to hell. In lands other than this, a living being only enjoys the

fruit of actions done here. There [in those lands] there is neither merit nor demerit [for actions done].

Divisions of the Bhārata land

87. In this land of Bhārata nine divisions have been marked of old in a definite order by the sons of Sagara; they too are enumerated here.

88-90. Indradvīpa and Kaśeru make two, and then Tāmraparṇa and Gabhastimān, Nāga and Saumya, and Gāndharva and Vāruṇa make eight. The ninth is the island Kumārī surrounded by the ocean. Its eastern end is occupied by Kirāta-s, the western [end] by Yavana-s, and the middle by the twice-born, etc. Six islets are demarcated in this Kumārī island and they are known as Aṅga, Yava, Malaya, Śaṅkhaka, Kumuda and Varāha.

Mountains of Bhārata

91. There are seven secondary mountains [in Bhārata] known as Ṛkṣa, Mahendra, Vindhya, Malaya and Sahya, then Śuktimān and the last named Pāriyātra.

92a. Those learned in the Śāstra-s say that the castes and stages of life (*āśrama-s*) are specially discernible only here [in Bhārata].

The situation of Laṅkā

92b. Laṅkā is situated at the top of the central peak of the Malaya mountain in the Malaya island,

Kerala

93-94. Stretching north-south at the foot of the Sahya mountains is the land of Paraśurāma (Kerala); of the sacred places here, Saptakoṭīśvara, the place called Bilva-parvata, Gokarṇa, Anantapura, and Āmalaka at the foot of the Sahya [ranges]—these are specially spoken of as giving enjoyment and salvation.

Sacred places elsewhere in Bhārata

95-96. There are numerous divine places also in other parts of the land like Kāśī, Sālagrāma, Ayodhyā, Kurukṣetra, Harihara, Śrīraṅga, Mallikārjuna, and Puruṣottama. There exist in these places also sacred waters [rivers, lakes, etc.] which destroy the sins of mortals by [mere] contact.

Rivers in Bhārata

97. There are [in Bhārata] rivers like Śatadru rising from the foot of the Himalayas, and those like Vedavadanā and Smṛtivadanā originating from the Pāriyātra mountains.

98. The Surasā, Narmadā and others are said to rise from the Vindhyas. The Tāpī and Payoṣṇī, and likewise Nirvindhyā start from the Ṛkṣa mountains.

99. The Bhīmarathā and others like the Godāvarī start from the foot of the Sahya mountains. Rivers which start from the Malaya mountains are Kṛtamālā, Tāmraparṇī and the like.

100. Rivers like Ṛṣikulyā are said to originate from the Mahendra mountains; and Ṛṣikūlā and

others like the Kumārā rise from the Śuktimat ranges.

101a. Numerous are the tributaries which are fit to be resorted to by mortals.

101b. Thus has been stated in brief [the description of] the Jambū island with its divisions.

Residents of other islands

102. Those who live in other islands do not have diseases and other [ailments]. Their age is stated to be five thousand years.

Other worlds

103. The [upper] worlds have been stated to be seven by the Puranic authors, and so also the nether worlds [*pātāla-s*]. The [upper] worlds are Bhūḥ, Bhuvaḥ, Svaḥ, Mahaḥ, Janaḥ, Tapaḥ and Satya.

104. Bhūḥ is this Earth, and hence it is beneath the region of the heavenly bodies. So also [i.e., beneath the heavenly bodies] is Bhuvaḥ. This [latter] is full of Gandharva-s, Yakṣa-s, Rākṣasa-s, Bhūta-s, Piśāca-s and the like.

105. The world Svaḥ is above this, and it is pervaded by divine beings, aerial vehicles and celestial bodies. The world named Mahaḥ is still higher and is full of groups of sages like Vasiṣṭha, Pulastya, etc.

106. Above it is Janaḥ filled with groups of great sages like Bhṛgu. Tapaḥ is above this and is filled with great sages like Sanaka.

107. [The world] named Satya is above this and there [reside] the Creator [Brahmā] and the liberated souls [*paramahaṃsa-s*]. Beyond is the sky, and at its [upper] end is the location of the upper shell of the Universal Egg [*brahmāṇḍa-kapāla*].

108. The seven nether worlds, Atala, Vitala, Sutala, Nitala, Talātala, Mahātala and Rasātala are below the Earth. They are delightful regions.

109. They are said to be filled with the eight Great Serpents, Asura-s like Mahābali, and also by Hayagrīva and others.

110. The world called Hell [*Naraka*] is 'below', and still 'below', is what is called the Secondary Hell [*Upa-naraka*]. Still 'below', is the lower shell of the Universal Egg. Thus have been described [the world] by Puranic authors.

Thus, in *The Light of Spherical Astronomy*,
is the Third Chapter entitled
"Conception of the Earth, etc."

CHAPTER IV

The Earth-line

1a. The Earth-line (or line on the horizontal plane, *Bhū-sūtra*[1]) is a line drawn from one horizon to

[1] The term *Bhū-sūtra* is suggestive of the fact that what is described in the following verses can be demonstrated by means of strings on the armillary sphere, the details of whose construction are given in Ch. I above.

the opposite horizon passing through the centre of the Earth.[1]

The Great gnomon and the Great shadow

1b. The perpendicular line dropped from the Sun to the Earth-line is the Great gnomon (*Śaṅku* or *Mahā-śaṅku*).

2a. The distance from the foot of the Great gnomon to the centre of the Earth is termed its Great shadow (*Chāyā*)

2b. These two [the Great gnomon and the Great shadow] form the Base (*Doḥ*, *Bhujā*) and the Perpendicular (*Koṭi*); and the Radius (*Trijyā*)[2] is their hypotenuse. By these three a [right-angled] triangle [is formed].

Or, let the hypotenuse be the [perpendicular] distance from the horizontal plane to the Sun upon [the plane of] the diurnal circle (*Dyuvṛtta*); the Perpendicular here will be the Great gnomon and the Base the *Śaṅkvagra* [*viz.*, the distance between the foot of the Perpendicular and the foot of the Great gnomon]. Thus too is a [right-angled] triangle formed.

4. The Perpendicular on the diurnal circle is to be derived by proportion with the *Kāla-jyā*[3]: If *Kāla-jyā*

[1] The Earth-line represents the line joining the intersections of any vertical circle with the horizontal plane, and not necessarily the east-west line. It may also be noted that what is envisaged here is a horizontal plane passing through the *centre* of the Earth and not one on the *surface* of the Earth.

[2] *Trijyā* or the radius of the Celestial sphere is translated here by the term 'Radius'.

[3] *Kāla-jyā*, i.e., the sine of the angle between two points of time, is found in the forenoon by converting the time elapsed

is represented by that much [part of the arc on the diurnal circle between the Sun and the horizon] when measured with reference to the Radius, how much will the arc be if [the same angle is measured with reference] to the diurnal circle itself?[1]

5. Always [when the hour-angle is measured] it is proper to measure sines, etc., from the *Unmaṇḍala*, and not from the horizon; for it is the *Unmaṇḍala* that passes along the sides of the revolving [Celestial] sphere.[2]

6. Therefore [when the Sun is] in the [northern and southern] hemispheres respectively, the ***Kāla-jyā*** is to be derived by [first] finding the sine for the time obtained by subtracting or adding the *Cara-dala* (the difference in duration of 15 *nāḍikā-s* between the actual half-day time and mean half-day time to the elapsed time [in the forenoon] or to the time to elapse [in the

from sunrise into degrees (1 *nāḍikā* = 6 degrees) and finding the sine (*jyā*) for that angle; in the afternoon the time to reach sunset is to be thus converted.

[1] The ***Kāla-jyā*** for the moment is represented by the arc in the particular diurnal circle, when measured with reference to the Radius. What is required is to find its corresponding measure for the same hour-angle on the diurnal circle itself. This latter being a smaller circle, the measure of the arc for the same angle will also be smaller.

[2] The ***Unmaṇḍala*** is the great circle passing through the celestial poles making an hour-angle of 90° with the Meridian (see I. 11-12 above). The horizon at a particular place may be below or above the *Unmaṇḍala* according to the latitude of the place. Hence the hour-angle of a celestial body at the Meridian may be more than 90° if measured from the horizon when it is below the ***Unmaṇḍala***. Angles are measured in a quadrant and tabular sines are provided for a maximum of 90° and hence sines of angles greater than 90° cannot be read out from the tables. Hence it is specified that the hour-angle should be measured from the ***Unmaṇḍala*** and not from the horizon.

is represented by that much [part of the arc on the diurnal circle between the Sun and the horizon] when measured with reference to the Radius, how much will the arc be if [the same angle is measured with reference] to the diurnal circle itself?[1]

5. Always [when the hour-angle is measured] it is proper to measure sines, etc., from the *Unmaṇḍala*, and not from the horizon; for it is the *Unmaṇḍala* that passes along the sides of the revolving [Celestial] sphere.[2]

6. Therefore [when the Sun is] in the [northern and southern] hemispheres respectively, the *Kāla-jyā* is to be derived by [first] finding the sine for the time obtained by subtracting or adding the *Cara-dala* (the difference in duration of 15 *nāḍikā-s* between the actual half-day time and mean half-day time to the elapsed time [in the forenoon] or to the time to elapse [in the

from sunrise into degrees (1 *nāḍikā*=6 degrees) and finding the sine (*jyā*) for that angle; in the afternoon the time to reach sunset is to be thus converted.

[1] The *Kāla-jyā* for the moment is represented by the arc in the particular diurnal circle, when measured with reference to the Radius. What is required is to find its corresponding measure for the same hour-angle on the diurnal circle itself. This latter being a smaller circle, the measure of the arc for the same angle will also be smaller.

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afternoon], and then adding to or subtracting from it, respectively, the *Cara-jyā* (the sine for the *Cara-dala*).

Finding the Great gnomon when latitude and declination are known

7. The Great gnomon at the required time is found [by the proportion]: If the co-latitude (*Lamba*) is the Perpendicular when the celestial Radius is the hypotenuse, what will be [the Perpendicular] when the hypotenuse is the perpendicular [on the plane] of the diurnal circle?

Finding the Śaṅkvagra when latitude and declination are known

8. The *Śaṅkvagra* is found [by the proportion]: If sin. latitude is the *Bhujā* corresponding to a *Koṭi* equal to the co-latitude, what will be the *Bhujā* corresponding to a *Koṭi* equal to the Great gnomon.[above]?

[These proportionate calculations are proper] since all these figures are latitudinal [right-angled] triangles.

9. Or the Great gnomon is the *Iṣṭa-dvuvṛttajā-jyā* [1] multiplied by sin. declination and divided by sin. amplitude and the *Śaṅkvagra* is *Bhā-jyā* multiplied by the Great gnomon and divided by sin. declination.

Determination of the Great gnomon when the Sun is on the Prime Vertical

10. When the Sun is on the Prime Vertical, the *Śaṅkvagra* will be equal to sin. amplitude. The *Sama-śaṅku* (Great gnomon when the Sun is on the Prime

[1] See verse 4 above.

Vertical) may therefore be derived from its *Śaṅkvagra* which is the same as the sin. amplitude.

11. Or *Sama-śaṅku* may be derived by the inverse proportion of *Bhujā* and *Koṭi*: If the sin. co-latitude, *Lamba*[*-jyā*], is the *Koṭi* for sin. latitude, *Pala*[*-jyā*], what must it be for the *Śaṅkvagra*?

The Great gnomon at the corner directions[1]

12-13a. The Base is always the distance from the foot of the Great gnomon to the east-west line. Similarly the distance from the foot of the Great gnomon to the north-south line is the Perpendicular. The shadow is their hypotenuse. By means of these the Great gnomon at any required direction may be derived.

13b-14a. The Base of the hypotenuse of the shadow (*Chāyā-karṇa*) is the sum of the *Śaṅkvagra* and sin. amplitude when they are in the same direction, and their difference when they are in opposite directions [to each other]. By means of these two, the Perpendicular too can be derived.

14b. When the Base is equal to the Perpendicular, then the Sun will be in a corner direction.

15. To derive the Great gnomon at a corner direction, calculation by repeated approximation has to be done intelligently.

[Thus:]

[Case 1:] When the Sun is south [of the Equator], if the Perpendicular is shorter [than the Base], a little

[1] i.e., the intermediate directions, 45° from the N-S and E-W lines.

should be subtracted from the elapsed *nāḍikā-s* [in the forenoon] and the *nāḍikā-s* to elapse [in the afternoon].

16. In case the Base is shorter, a little should be added to the *nāḍikā-s* elapsed or to elapse.

[Case 2:] The same should be done also when the Sun is in the northern [hemisphere] and is moving only [along diurnal circles] on the same [northern] side [of the observer's position].

17. [Case 3:] [When the Sun is in the northern hemisphere and] if its motion is [along diurnal circles which extend] on both sides [north and south, of the observer's position]:

(a) to get the Great gnomon at the south, the same [procedure, *viz.*, subtraction and addition] should be made as above; and,

(b) to derive the [corner] Great gnomon [if any] on the north [the addition and subtraction] should be reversed. The number [of *nāḍikā-s*] to be subtracted [or added] should be intelligently guessed.

18a. By some, the difference [in minutes] between the Base and the Perpendicular is subtracted or added to [the time elapsed or to elapse, converted into] *prāṇa-s*.[1]

[1] The *prāṇa* is a time-measure equal to 4 seconds. This procedure is suggested because the Celestial sphere revolves by 1' in one *prāṇa*; of course, this is not directly connected with the number of minutes contained in the respective sines. That the author accepts this as a helpful method is evident from his use of it in the example given below in verse 23.

To find the Great gnomon in any direction

18b-19a. Taking the desired direction in a circle with *Trijyā* as radius, the Base of the angle arising from it is to be found. This multiplied by the Shadow and divided by the Radius will be the Base for that direction.[1]

19b. If the Base of the Shadow [at the observed time] is equal to this, then the Base in the desired direction.

20. If different, their equality should be arrived at as before [by the method of repeated approximation.] The difference [in *kalā-s*] of the two Bases [*viz.*, the calculated Base in the desired direction and the observed Base in any direction] should be subtracted from or added to [the time in *prāṇa-s*] intelligently as before.

21. If in the calculation by repeated approximation the equality of the desired result is slow [in approach] the subtraction or addition may be made [at the rate of] one and a half times or twice [the difference].

22. When too quick, it may similarly be taken as a third less or as half.

The Great gnomon at the desired direction is obtained by the rule stated above.

Examples

Some examples regarding the Shadow are shown here :

[1] The purpose of this is to reduce the sine measured on the *Trijyā-vṛtta* to the *Chāyā-vṛtta*.

Problem :

23. The True Sun is at the middle of *Meṣa*. What is the *Sama-śaṅku*? The Great gnomon at the south-east is to be stated as also that [i.e., the Great gnomon] midway between south-east and east,[1] [given] sin. latitude [at the place] is 647.

[Answer]

Here sin. latitude is equal to 647; sin. co-latitude calculated from this is equal to 3377. The sin. amplitude obtained from this and [the given] Sun is equal to 368. This multiplied by sin. co-latitude and divided by sin. latitude is the *Sama-śaṅku*. That is equal to 1921.

In the calculation of the Great gnomon at the corner direction, let the elapsed *nāḍikā-s* be assumed as 8. The Great gnomon calculated from this is equal to 2516; and the *Śaṅkvagra* 482. The Great shadow is therefore equal to 2343. And that is [itself] the hypotenuse [since a corner direction is taken]. Here the sin. amplitude [calculated previously] is 368. When *Śaṅkvagra* and sin. amplitude are in opposite directions their difference will be the Base of the Great shadow which is the hypotenuse. [Here] it is equal to [482 — 368] 114. The difference between the squares of this Base and the Great shadow will be the Perpendicular. That, in the present instance, is 2340.

Here the Base and the Perpendicular being different, and the Perpendicular being greater, their

[1] Agni is the Lord of the S.E. direction and *Śakra* (Indra) of the East.

difference [2340 − 114 = 2226] should be added to the number of *asu-s* [i.e., *prāṇa-s*] in the original 8 *nāḍikā-s*. The elapsed *asu-s* thus derived are equal to [2880 + 2226] 5106. The Great gnomon derived therefrom is equal to 3407 and the Great shadow is equal to 468. The Base of the shadow is equal to 285. The Perpendicular [calculated] therefrom is 362.

Here too the Perpendicular being greater, the difference between the Base and the Perpendicular [77] should be added to the elapsed *asu-s* [5106]. The elapsed *asu-s* thus derived are 5183. The Great gnomon, etc., should be calculated from these and the calculation continued as before. In this calculation by repeated approximation if the Perpendicular is shorter than the Base, the difference between the Base and the Perpendicular should be subtracted from the elapsed *asu-s* and the Great gnomon, etc., calculated. Thus calculated by repeated approximation, the Great gnomon in the corner direction in the present [problem] is equal to 3414.

Now in the calculation of the Great gnomon in a direction midway between east and south-east, let the elapsed *nāḍikā-s* be taken as 8. The Great gnomon derived from this is equal to 2516. Its Great shadow is equal to 2343. The Base of the Great shadow is equal to 114. Here, since the Great gnomon is midway between east and south-east, the required Base will be formed by one-fourth of a quadrant in the *Trijyā* circle. That Base multiplied by the Great shadow at the moment and divided by *Trijyā* will be the Base

difference [2340 − 114 = 2226] should be added to the number of *asu-s* [i.e., *prāṇa-s*] in the original 8 *nāḍikā-s*. The elapsed *asu-s* thus derived are equal to [2880 + 2226] 5106. The Great gnomon derived therefrom is equal to 3407 and the Great shadow is equal to 468. The Base of the shadow is equal to 285. The Perpendicular [calculated] therefrom is 362.

Here too the Perpendicular being greater, the difference between the Base and the Perpendicular [77] should be added to the elapsed *asu-s* [5106]. The elapsed *asu-s* thus derived are 5183. The Great gnomon, etc., should be calculated from these and the calculation continued as before. In this calculation by repeated approximation if the Perpendicular is shorter than the Base, the difference between the Base and the Perpendicular should be subtracted from the elapsed *asu-s* and the Great gnomon, etc., calculated. Thus calculated by repeated approximation, the Great gnomon in the corner direction in the present [problem] is equal to 3414.

Now in the calculation of the Great gnomon in a direction midway between east and south-east, let the elapsed *nāḍikā-s* be taken as 8. The Great gnomon derived from this is equal to 2516. Its Great shadow is equal to 2343. The Base of the Great shadow is equal to 114. Here, since the Great gnomon is midway between east and south-east, the required Base will be formed by one-fourth of a quadrant in the *Trijyā* circle. That Base multiplied by the Great shadow at the moment and divided by *Trijyā* will be the Base

pertaining to that direction (*Digbhujā* or *Digbāhu*), the proportion being: If this much is the Base in the *Trijyā* circle, how much will it be in the Shadow circle? The *Dig-bhujā* thus obtained will be 896.

Here the two *Bhujā-s* being different and the *Dig-bhujā* being greater, the difference between the two [896−114=782] should be added to the elapsed *asu-s* [8 *nāḍikā-s*=2880 *asu-s*], the Great gnomon, etc., should be derived from those elapsed *asu-s* and the two *Bhujā-s* calculated again as before. Now the number of elapsed *asu-s* with the addition of the difference between the sides, is equal to [2880 + 782] 3662. The Great gnomon therefrom is equal to 2971. Its shadow is equal to 1730. The Base of the Shadow is equal to 201. The *Dig-bhujā* obtained therefrom [by the proportion stated above] is 662.

Here slowness of the approach to equality of the *Chāyā-bhujā* and *Dig-bhujā* is observed. Hence their difference should be doubled and added to the elapsed *asu-s* and the Great gnomon, etc., calculated as before. The elapsed *asu-s* thus obtained are equal to [3662+(2×461)=] 4584. The Great gnomon therefrom is 3314. The Shadow is 915. The Base of the Shadow is equal to 266 and the *Dig-bhujā*, 350.

The difference between these two [350−266=84] should be doubled and added to the elapsed *asu-s*. The elapsed *asu-s* so obtained are equal to [4584+168] 4752. The Great gnomon [therefrom] is 3352. The Shadow from that is equal to 764. The Base of the Shadow is equal to 274. The *Dig-bhujā* [by proportion] is equal to 292.

Here too the difference between the two bases [18] should be doubled and added to the elapsed *asu-s* [4752], the *asu-s* so obtained being 4788. The Great gnomon therefrom is equal to 3360. The Shadow is 728. The Base of the Shadow is 276, and the *Dig-bhujā* is 278.

Now the difference between the two *Bhujā-s* is only 2. When this is doubled and added to the elapsed *asu-s* [4788], and the Great gnomon derived, it will be increased by 1 *kalā* only. Hence the Great gnomon in a direction midway between east and south-east is 3361. Thus the Great gnomon in any desired direction can be calculated.

The 12-inch gnomon

24a-b. From the *prāṇa-s* which have elapsed at the desired [time] and the True Sun at that time, the Great gnomon, its *Agra* [i.e., *Śaṅkvagra*], the Shadow and sin. amplitude are to be calculated.

24b-25a. The Base of the Shadow is the sum of the *Śaṅkvagra* and sin. amplitude when they have the same direction and their differences when they are in opposite directions.[1]

25b. The Shadow of the 12-inch gnomon [at that time] should also be calculated from the *prāṇa-s* which have elapsed.[2]

[1] Cf. verses 13-14 above.

[2] This can be done due to the similarity of the 12-inch gnomon shadow triangle and the Celestial or *Mahā-śaṅku* triangle (see footnote 1 on p. 129).

$$\text{12-inch gnomon shadow} = \frac{12 \times \textit{Trijyā}}{\textit{Mahā-śaṅku}}$$

26. Having multiplied the Shadow of the 12-inch gnomon by the Base of the [Celestial or Great] shadow, divide [the product] by the Great shadow.[1] The result is the desired true Base in the desired [12-inch gnomon shadow] circle.[2]

Diagrammatic representation of the Path of the Gnomonic shadow

27a. Draw on a level surface a circle using [as radius the length of] the Shadow of the 12-inch gnomon and with the lines of directions [i.e., N-S and E-W, marked on it].

27b-28b. In that [circle] slide along [the E-W line] from its east and west [extremities] on the side of the Shadow [i.e., on the north or south side of the E-W line], an arrow-head of length equal to the required Base, with its pointed end turned towards the south or north as the case may be so that [one of] its two ends rests on the E-W line and [the other] on the circumference [of the circle].

28b-29a. Mark the two points of contact of the circumference and the arrow-head, one on the western side and [the other] on the eastern side.

[1] This is the Celestial or Great shadow defined in verse 2 of this chapter and denoted by the term *Chāyā* (Shadow) all along. The distinct name *Mahā-Chāyā* is now used to distinguish it from the 12-inch gnomon shadow (*Dvādaśāṅgula-śaṅku-chāyā*) which is newly introduced here. The term *Mahā-śaṅku* is similarly contrasted with the term *Dvādaśāṅgula-śaṅku*.

[2] This is due to the similarity of the two triangles,—

Base in 12-inch gnomon shadow circle : Base of Great shadow : : 12-inch gnomon shadow : Great shadow

29b-30a. Or place a double arrow-head of [total] length equal to twice the length of the required Base, with its middle on the E-W line and the two pointed ends on the circumference and mark the two points at its ends [i.e., west or east, on the side of the shadow, i.e., north or south of the E-W line].[1]

30b-31a. A third point is now marked on the N-S line at the tip of the shadow of the 12-inch gnomon at midday.

31b. Construct the arc of the circle touching the three points by the method prescribed for it.

32a. The shadow of the gnomon [fixed] at the centre of the [first] circle, i.e., that on which the directions are marked, will move with its end along this arc.

The shape of the gnomon

32b. The gnomon tapers gradually towards the end, is circular [in section], pointed at the tip and twelve inches [*aṅgula*-s] in length.

Accurate method for constructing the Path of the Shadow

33. Some calculate two different shadows and the two [corresponding] Bases from two positions of the Sun at two times [one in the forenoon and the other in the afternoon] and mark the two points on [the circumferences of] the respective circles where their respective Bases [on the E-W line] touch them.

[1] The latter method is suggested for greater accuracy.

34a. In this case the error arising from the difference in declination [of the Sun] in the east and the west [i.e., in the forenoon and the afternoon respectively] does not occur.

34b. The motion of the shadow has been enunciated thus by *Golavid.*[1] Its method [of construction] may also be observed here:

35-36. Describe three equal circles with the three points as centres, so that two fish-figures are formed [by the intersecting circles]. Draw the lines through the middle of the two fish-figures [and extend them]. With their meeting point as centre describe a circle to pass through one of [the three] points. All the three points will be on this circle.

Finding the True Sun from the Corner shadow and the 'Time from Noon'

37. Observe the time with the help of a time-measuring device [starting] from the moment when the Sun is at a corner direction up to the middle of the day. That [interval of] time is called 'Time from Noon'[2] (*Nata-kāla*).

38a. The root of the sum of the squares of the shadow at the corner direction and 12, is the hypotenuse of the shadow at the corner direction.

38b. By means of the shadow at the corner direction, the corresponding hypotenuse and the gnomon,

[1] This might be a reference to Mādhava, the author's teacher, who is generally styled *Golavid.*

[2] By noon is meant here 'True noon' and not 'Mean noon'.

the Great gnomon at the corner direction and sin. zenith distance (*Dṛgjyā*) can be derived.[1]

39. When the Sun is at the corner direction, the Base and the Perpendicular of the Hypotenuse in the form of the shadow have been said to be equal. And hence the measure of the Base and the Perpendicular is equal to the root of half the square of the shadow.

40a. Here what extends east to west is the Perpendicular, and what extends north to south is the Base.

40b. The Perpendicular in the diurnal circle extending east to west is equal to the Perpendicular in the shadow-circle.

41a. The east-west Perpendicular on the Celestial Equator [corresponding to the Perpendicular in the diurnal circle] is equal to the sine of the hour-angle (*Nata-jyā*).

41b. This being the case it is possible to derive the radius of the diurnal circle also by the similarity [of the two triangles thus:]

42. If the sine of the hour-angle corresponds to the 'Perpendicular' in the diurnal circle, how much will the Radius correspond? This will be the radius of the diurnal circle.[2]

43. From the radius of the diurnal circle the declination [can be derived].[3] The *Bhujā* arc obtained

[1] This follows from the similarity of the triangles.

[2] i.e., *Natajyā* : *Dyuvṛtta-koṭi* :: *Trijyā* : *Dyuvṛtta-vyāsārdha*.

[3] Since the radius of the diurnal circle is equal to cos. declination, sin. declination may be derived from it by using the formula: sin. decl. $= \sqrt{Trijy\bar{a}^2 - \cos^2 \text{decl.}}$

from the declination[1] will be [the longitude of] the Sun.

[The longitude of] the Sun may also be 180° plus the arc, 180° minus the arc or 360° minus the arc.[2]

44. If the Great shadow at a southern corner direction is [gradually] increasing, [the Sun] is on the southward march; when the Great shadow is decreasing there, it is on the northward [march]. The reverse is the case with reference to the northern corner direction.

45a. Observing the 12-inch gnomonic shadow on two consecutive days, the [northward or southward] march [of the Sun] should be determined as instructed above.[3]

45b. The hemisphere [in which the Sun is] is understood from [the position of] sunrise.[4]

And from these two [the correct position of] the Sun is determined.[5]

[1] $\sin. \textit{Bhujāṃśa} = \dfrac{\textit{Krāntijyā} \times \textit{Trijyā}}{\textit{Parama-krāntijyā}}$, i.e., $\dfrac{\sin. \textit{Krānti}}{\sin. 24^{\circ}}$

[2] Because for the same sin. *Bhujāṃśa,* the Sun may be in any of the four quadrants in the four positions stated in this verse.

[3] The southward march, *Dakṣiṇāyana,* i.e., passage from the summer solstice to winter solstice, *Karkyādi* to *Makarādi,* pertains to the second and third quadrants and the northward march, *Uttarāyaṇa,* to the fourth and first quadrants.

[4] This follows from the fact that when the Sun is in the northern hemisphere its point of rise will be north of the east-point and *vice-versa.* This observation, therefore, indicates in which set of quadrants, one and two, or three and four, the Sun is.

[5] As is obvious from footnotes 2 and 3.

Determination of latitude from the Corner shadow

46a. The latitude can [now] be determined by the method of repeated approximation. The method for that is also stated here.

46b. To the sin. declination [obtained above] add a small [number] and take this as sin. amplitude to start with.[1]

47a. The sum of the Base of the Shadow and sin. amplitude when in opposite directions and the difference when in the same direction is the *Śaṅkvagra*.[2]

47b. The root of the sum of the squares of the Great gnomon and the *Śaṅkvagra* is the 'Perpendicular in the plane of the diurnal circle'.[3]

48a-b. By this, divide the *Śaṅkvagra* which has been multiplied by the Radius. The result will be [the approximate] sin. latitude.[4]

48a. Derive sin. co-latitude from sin. latitude.

49. Radius multiplied by sin. declination and divided by sin. co-latitude will be sin. amplitude.[5]

[1] Sin. amplitude being $\frac{\text{sin. decl.}}{\text{cos. lat.}}$, it will always be greater than sin. decl.

Here in the absence of a knowledge of the latitude, a small number is to be added to it and the sum taken as sin. amplitude to begin the calculation by repeated approximation (*Aviśeṣa-karma*).

[2] This is just the reverse of the method given for finding the Base in verses 13-14 above.

[3] Since the *Śaṅku*, *Śaṅkvagra* and the *Svāhorātra-vṛttajā-jyā* (i.e., *Dyuvṛttajā-jyā*) make the right-angled triangle mentioned in verse 3 at the beginning of this chapter.

[4] Since the above is a latitudinal triangle (*Akṣa-kṣetra*) having the angle at the apex equal to the latitude.

[5] $\frac{R \times \text{sin. decl.}}{\text{sin. co-lat.}}$, i.e., $\frac{\text{sin. decl.}}{\text{cos. lat.}}$ = sin. amplitude, taking R = 1.

The *Śaṅkvagra* can be derived as before from the base of the shadow and [the present revised value of] sin. amplitude.

50. The root of the sum of the squares of the Great gnomon and the *Śaṅkvagra* will be the 'Perpendicular on the diurnal circle'. The *Śaṅkvagra* multiplied by the Radius and divided by the 'Perpendicular on the diurnal circle' will be sin. latitude.

51. Sin. co-latitude is again derived from this; and again sin. amplitude from the declination as before. The process should be repeated till there is no difference [in the result]. When there is no difference [in the result] that will be the exact sin. latitude.

Determination of the longitude of the Sun from the Noon-day shadow

52a. When the latitude is known, [the longitude of] the Sun can be derived from the noon-time shadow as well.

52b-53a. When the Sun is to the south [of the zenith], the difference between the zenith distance and the latitude is the angle of declination; when the Sun is to the north, their sum is the angle of declination. From declination, [the position of] the Sun is [determined] as before.

Determination of the Sun from the Sama-śaṅku

53b. The *Śaṅkvagra* is derived from the *Sama-śaṅku* (the Great gnomon when the Sun is on the Prime Vertical); that itself is sin. amplitude. From that the

declination [is determined][1] and from the declination, the Sun.

Diameter of the Earth's shadow

54. The shadow of the Earth extends in a direction away from the Sun, is long and always circular [in section]; at the base its circumference is equal to that of the Earth and at the end it is [tapering] like a cow's tail.

55. The orb of the Sun is huge and its rays falling along the circumference of the Earth pass around it like hypotenuse[-lines] and hence its shadow tapers gradually [towards the end].

56. The radius of the Sun reduced by the radius of the Earth is the gnomon; its shadow is the Sun's [orbital] hypotenuse [i.e., its true distance from the Earth: if this be so what will it [*viz.*, the shadow] be for a gnomon equal to the radius of the Earth? From this [proportion] the length of the [Earth's] shadow can be obtained.

57. Divide by the length of the [Earth's] shadow, the length of the Earth's shadow reduced by the [orbital] hypotenuse of the Moon [i.e., its true distance from the Earth] and multiply [the quotient] by the diameter of the Earth; the result will be the diameter of the shadow at the position of the Moon.

58. The [illegible]ng here is [this]: If the diameter of the shadow for a distance equal to its [full] length

[1] This is the reverse of the process enunciated in vv. 10-11 above.

to the tip is equal to the diameter of the Earth, how much will it be for a distance equal to the length of the shadow reduced by the [orbital] hypotenuse of the Moon?

Angular dimensions of the orbs

59. If the diameter of the orb in *yojana-s* corresponds to the [orbital] hypotenuse in *yojana-s*, what will be if the hypotenuse is taken to be the minutes con-[illegible]ed in the Radius, i.e., 3438?[1] [By means of this proportion] the angular diameters of the Shadow, the Moon and the Sun can be determined.

R[illegible]n for the difference in the appearance of the [illegible]s of the Sun and the Moon

60. The Solar eclipse is the hiding of the Sun by the Moon which is below it. Hence the measure of the hidden portion of the Sun is different from place to place; and so also the duration of the eclipse.

61. The Lunar eclipse is the entrance of the Moon into [the shadow [illegible] the Earth] which is the same for all places; hence, the measure of the hidden portion and also the duration [are the same in all places].

Parallax in yojana-s

62. The S[illegible] the M[illegible]n, though having the same position [illegible]ured] by minutes [i.e., are in

[1] When the number of minutes in a circle, 21600, is taken to be represented by its circumference, a length equal to the radius will measure 3438 minutes.

conjunction in longitude], are seen by people on the surface of the Earth to be east or west of one another; [this is] because [the Sun is] above and [the Moon] below.

63. Since the centre of the Earth is the centre of the orbits of the Planets and the observer is on the surface of the Earth, the difference between them will be the measure of the difference in Parallax between them.

64a. The Vertical circle (*Dṛṅmaṇḍala*) has the observer [on the surface of the Earth] as its centre and passes through the Planet.

64b. The *Dṛk-kṣepa-maṇḍala* likewise [has the observer as its centre] but passes through the Nonagesimal (*Dṛk-kṣepa-lagna*) [which is a point on the Ecliptic 90° less from the *Lagna* or rising-point of the Ecliptic].

65a. [For a particular point] on the surface of the Earth, the horizon is a circle on a plane, horizontal with the Earth's surface [at that point] and bisecting the Vertical circle [which is at right angles to it].

65b. When the Sun is on this horizon, the Great gnomon is zero and when [the Sun] is at the zenith, the Great gnomon is equal to the Radius.

66a. Thus is the Great gnomon with reference to the surface of the Earth; the Great gnomon with reference to [the plane through] the centre of the Earth has already been derived by calculation.[1]

66b. The difference between the Great gnomon [as viewed] from the Earth's surface and that from the

[1] As is obvious, it is this Great gnomon that is defined in verse 1, l. 2, of this chapter and has been used for calculations, etc., in the previous sections.

Earth's centre is the Parallax (*Lambana*) of the Planet, [here the Sun or the Moon].

67a. At sunrise the difference of the two gnomons in *yojana-s* is equal to the radius of the Earth [in *yojana-s*].

67b. It is zero when the Sun is at the zenith. Hence it [*viz.*, this difference] has to be calculated according to sin. zenith-distance [thus:]

68. If by the Radius, [the difference measured] is equal to the radius of the Earth, what [illegible] be by sin. zenith-distance? Thus will be [obtained] the difference between the two gnomons in *yojana-s*.

69. For all Planets in the same [position, measured in] minutes, the Parallax in *yojana-s* (*Lambana-yojana*) is the same; Parallax in minutes (*Lambana-liptā*) however, varies due to their [moving in] different orbits.

70. The difference between the Parallaxes of the two Planets [the Sun and the Moon] in minutes is equal to their [apparent] difference [in longitude when they are in conjunction].

For a Planet having a faster motion, the Parallax in minutes will be greater because of its smaller orbit.

The term Lambana

71. Since a Great gnomon [from a vertical circle] to the surface of the Earth (*Kupṛṣṭha-śaṅku*) is shorter than a Great gnomon to [the horizontal plane passing through] the centre of the orbit, the term *Lambana* ('hanging downward') is applied to the difference between the two gnomons.

Resolving the Lambana

72. This [total] *Lambana* [mentioned above] is obtained hypotenuse-wise. The part forming its Base is the Parallax [in longitude, the *Lambana* proper] and is applied [in terms of time] to the New Moon. The part forming its Perpendicular is the Parallax in latitude (*Nati*).

73. For the sin. zenith-distance taken as hypotenuse, the sin. zenith-distance of the Nonagesimal (*Dṛk-kṣepajyā*) is the Perpendicular; its Base is sin. altitude of the Nonagesimal (*Dṛggati*). From these two, the Parallax in latitude (*Nati*) and Parallax in longitude (*Lambana*) are calculated in the case of Solar eclipses.

Conversion of Parallaxes in latitude and longitude

74. Multiply by sixty the difference in Parallax in minutes of the Sun and Moon and divide it by their difference in daily motion in minutes. The result will be [their difference in] Parallax in *ghaṭikā-s*.

75. Parallax in terms of minutes is derived from the argument: If for the *yojana-s* equal to the [orbital] hypotenuse [i.e., the distance of the Planet from the Earth], the Parallax is the known *yojana-s*, what will it be [in *kalā-s*] if the [orbital] hypotenuse is taken to be [3438] minutes; for, the [orbital] hypotenuse is equal to the minutes in the Radius [*viz.*, 3438].

76. When the Planet is at the Nonagesimal (*Dṛk-kṣepa-lagna*), the sin. zenith-distance of the Nonagesimal itself will be sin. zenith-distance. The Parallax when at the Nonagesimal will always be the Parallax

in latitude of the Planet [whatever be the zenith distance of the Planet].

77. For any sin. zenith-distance taken as hypotenuse, the Perpendicular is always the sin. zenith-distance of the Nonagesimal. Hence the zenith-distance of the Nonagesimal (*Dṛk-kṣepa*) is always the means of calculating the Parallax in latitude of a Planet.

78. In the same manner, as there is a difference between a Great gnomon on [the plane of] the Earth's surface and one on [the plane passing through] the Earth's centre due to the difference in the [positions of the centres of] the circles, so a difference arises between the Mean and True [positions of Planets] due to the difference [in the centres] of their orbits and epicycles.

Determination of the rising of the Signs

79. The method for deriving the ascensional equivalents of *Meṣa* and other Signs at Laṅkā [i.e., on the terrestrial equator] is now given:

In a right-angled triangle, the hypotenuse will represent the sin. of the given arc [along the Ecliptic], the Base will represent the sin. of [the corresponding portion of] the diurnal circle; and the Perpendicular will be the [sin. of the] declination.

80. If for a hypotenuse equal to the Radius, the Base is the radius of the diurnal circle corresponding to the maximum declination [*viz.*, 24°] what will it be for the given hypotenuse equal to the sin. of the arc [on the Ecliptic]? By this proportion the sin. of the [corresponding] portion of the diurnal circle is obtained.

81. The *Kālajyā*[1] [corresponding to it is obtained by the proportion]: If this much is on the diurnal circle, how much will it be on the Great circle?

The *prāṇa-s* corresponding to the arc of this *kālajyā* will be the ascensional equivalent corresponding to the rise of the given arc [along the Ecliptic, mentioned in verse 79 above] at zero latitude, otherwise called right ascensional equivalent.

82. The sine of the given arc [on the Ecliptic] multiplied by 3141[2] and divided by the radius of the diurnal circle [at the point] and the result converted into arc [and then converted into time] will be the *prāṇa-s* for the rise of the given arc.

83. The difference between the [above] *prāṇa-s* calculated for the beginning and end of a given Sign is the time for the rise of that Sign.

That minus or plus the ascensional differences (*Carārdha-khaṇḍā-s*) respectively for the [six Signs] beginning with *Makara*, and [the six Signs] beginning with *Kaṭaka*, is the Oblique ascensional equivalent of the given Sign at a particular place.

84. The Starry sphere is elevated at the north. Hence [the six Signs] beginning with *Makara* rise quickly, and those beginning with *Kaṭaka* rise slowly. Hence is the application [negatively or positively] of the ascensional difference in the above manner.

[1] On *Kālajyā*, see IV, footnote 4.
[2] 3141 is the minimum *Dyujyā*, i.e., cos. (24°).

Precession of the Equinoxes

85a. Now a method of knowing the amount of the Precession of the Equinoxes is given.[1]

85b-86a. The difference [in the longitude] of the Sun as determined by the shadow and as derived for that moment by calculation [from astronomical texts] is said to be the Precession of the Equinoxes at that time.

86b-87a. Or find the moment when the Sun is free from southward or northward motion. The difference between the Sun at that time and the Solstice [i.e., the end of the *Ayana*, according to astronomical texts] will be [the amount of] the Precession of the Equinoxes.

87b-88a. The astronomer (*gaṇita-vid*) should take as the gnomon a very high pillar or the like and observe its noon-day shadow on its onward movement [north or south] and also on its backward movement.

[He should observe] the moment when the end of the shadow passes a given point on the onward movement and the moment when the end of the shadow comes back to the same point.

89b-90a. At the moment when the Sun is at [a position equal to] half the sum of the True Suns at the above two moments, the Sun will have been free from [northward or southward] motion.

90b. This [Precession of the Equinoxes] is determined either as additive or subtractive, by [the

[1] It is the Sāyana Sun that is to be used in the calculations contained in this chapter. Hence a method to measure the *Ayanāṃśa* is given here.

astronomer] versed in astronomical principles (*gaṇita-yukti-vid*).[1]

Conclusion

91-92. This, *The Light of Spherical Astronomy*, is composed in the Śaka year 1365 by one born from the face [of Puruṣa][2] named Parameśvara who resides in a village 18 *yojana-s* to the west of the central (Ujjain) meridian, having a sin. latitude equal to 647. May it live long in the minds of the great *Brāhmaṇa-s* who are great astronomers.

Thus, in *The Light of Spherical Astronomy*
is the Fourth Chapter

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[1] It is additive (*dhana*) when the longitude of the Sun derived from the shadow is greater than the value obtained by calculation from texts.

[2] i.e., a *Brāhmaṇa*.

CHAPTER VIII

GOLASĀRA OF NĪLAKAṆṬHA SOMAYĀJI

('QUINTESSENCE OF SPHERICAL ASTRONOMY')

Critically edited with

Introduction and Translation

CONTENTS

INTRODUCTION

Tradition of Astronomy in Kerala

The *Golasāra* presented here in a critical edition is an important minor work of Nīlakaṇṭha Somayāji, a noted astronomer of Kerala of the 15th-16th centuries. The Kerala region has a long tradition of astronomical studies, both at the empirical and experimental levels —a tradition which continued till the last century—under the enlightened patronage of local dignitaries and unhampered by alien or other invasions which disrupted such studies in several other parts of India. Many an innovation and discovery in mathematics and astronomy has been ascribed to scholars from this region.[1] Among the more important astronomers of the later period may be mentioned, Govinda Bhaṭṭatiri (A. D. 1237-95), Mādhava of Saṅgamagrāma (*c.* 1340-1425), Parameśvara of Vaṭaśśeri (1360-1455), Citrabhānu (*c.* 1475-1550), Śaṅkara Vāriyar of Tṛkkuṭaveli (*c.* 1500-60), Śaṅkaran Nampūtiri of Mahiṣamaṅgalam (1494-1570), Jyeṣṭhadeva (1500-1600), Acyuta Piṣāraṭi (*c.* 1550-1621), Putumana Somayāji (*c.* 1700-60) and Śaṅkaravarman of Kaṭattanāḍ (1800-38). Nīlakaṇṭha Somayāji, our author, belongs to this distinguished galaxy of astronomers and besides being the author of several texts on astronomy, is also a practical astronomer.

Golasāra

The *Golasāra* is a short work in 56 *āryā* verses, divided into three *paricchedas*, containing, respectively, 11, 15 and 30 verses. The first *pariccheda* sets out the basic astronomical constants, *viz.*, the number of civil days and the revolutions of the planets in an aeon, the positions of the higher apses and the ascending nodes of the planets, their maximum latitudes, their epicycles to the equations of the apses

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1. On Kerala mathematicians and astronomers, see: K. Sankara Menon, *Indian astronomy with special reference to the works of Kerala authors*, (Ph. D. Thesis, Madras University, 1927), T. A. Sarasvati, *Geometry in ancient and medieval India*, (Ph. D. Thesis, Madras University, 1964), and K. Kunjunni Raja, 'Astronomy and mathematics in Kerala (An account of the literature)', *Adyar Library Bulletin*, 28 (1963) 118-67.

and of conjunction, the diameters of the orbits of the sun and the moon and the *yojana* measures of the epicycles.

Pariccheda II is concerned with the presentation of the celestial globe (*Jyotirgola*) from the point of view of astronomical conceptions and observations and the movement, therein, of the heavenly bodies. The position of the great circles, *Ghaṭikā-maṇḍala* (celestial equator) and the *Apakrama-maṇḍala* (ecliptic), their mutual obliquity, the division of the ecliptic, the (apparent) rotation of the celestial globe, the rising point of the ecliptic (*lagna*), the measure of the orbits of the planets, the measurement of the positions of the planets on the ecliptic and the position of the horizon (*Unmaṇḍala*) at the equator and elsewhere are noticed here, in order.

In *Pariccheda* III, verses 1 to 15 deal with the circle and the graphical and computational derivation of the Sines. Verses 16 to 30 discuss the inter-relationship of the *Manda*, *Śīghra* and *Kakṣyā* circles of the different planets and also how the results arrived at by calculation of the positions of the planets are affected by their *kṣepa* (deflection) from the ecliptic.

Manuscript Material

The present edition of *Golasāra* is based on seven mutually independent palmleaf manuscripts, designated A to G, all originating from the Kerala region and written in the local script, *viz*., Malayalam. These seven manuscripts, however, sort themselves out into three distinct groups, group I being composed of Mss. A to C, Group II, of Mss. D and E, and Group III, of Mss. F and G.

Group I

A : Ms. No. C 1024-E of the Curator's Office collection of the Kerala University Oriental Res. Inst. and Mss. Library, Trivandrum, described in the *Des. Cata. of Skt. Mss. of the Curator's Office Library*. Vol. IV, pp. 1319-21, under Ser. No. 633-E. *Golasāra* is contained in the first few leaves of the manuscript, the rest being occupied by other miscellaneous matter ; possibly, on account of this, the Catalogue describes the work as incomplete. The Ms. belonged originally to the family collection of the Raja of Chirakkal in N. Kerala. There is also a transcript of this Ms. in the Library, No. T 846-B. The text contained is complete and fairly accurate. The textual verses are found arranged herein exactly as printed in the present edition, *viz*., in the *paricchedas* of 11, 15 and 30 verses, respectively.

The Ms. exhibits few scribal or other errors. The codex contains also other astronomical works, among which is another work of Nīlakaṇṭha, *viz.*, the *Siddhāntadarpaṇa*, numbered as C 1024-F.

B : Ms. No. 8358-E of the University collection of the above Library. The text contained is complete and generally correct. The arrangement of the verses follows that in **A**.

C : Catalogue No. 6301 of the India Office Library, London, described in the *Cata. of the Skt. and Pkt. Mss. of the India Office*, Vol. II, (Oxford, 1935), pp. 774-75. The collation was done on the basis of a microfilm copy of the Ms. supplied by the India Office. The text preserved herein is generally pure and the writing free from mistakes though the description in the *Catalogue* asserts that "the Ms. is very far from accurate". There is some astronomical matter written in continuation, which, too, the cataloguer has taken as part of the present work. The arrangement of the verses is as in **A** and **B**. The work written next in the codex is the *Siddhāntadarpaṇa* of Nīlakaṇṭha. One page of the manuscript has been left out from being photographed while microfilming the manuscript and hence the portion contained therein, being I.8d and to a portion of II.4d, could not be collated.

Group II

D : Ms. No, 1869-C of the Curator's Office collection of the Kerala University Mss. Library, described in the *Catalogue*, (*ibid*), p. 1343, as Ser. No. 636-B. The Ms. had been procured from Shri Brahmadattan Nampūtiri, Kudalur (S. Malabar). The text is incomplete, going only up to III. 24. Nīlakaṇṭha's *Siddhāntadarpaṇa* is found in continuation in the manuscript. The ms. takes I. 1-11 and II. 1-9 as *Pariccheda* I and II. 10-15 as *Pariccheda* II, the colophons reading accordingly ; *Pariccheda* III remains as it is.

E : A manuscript belonging to Shri Rama Varma Maru Thampuran, Chalakkudi (Cochin). The Ms. is generally correct, but breakes off with III. 24, even as D. does, but one is not a direct copy of the other as attested by minor differences in their readings. The verses are arranged as in D.

Group III

F : Ms. No. 5867-B of the University collection of the Kerala University Mss. Library. The Ms. is well preserved and generally

accurate. It omits the first *Pariccheda* entirely, designates verses II. 1-9 as *Pariccheda* I, and II.10 and 15 as *Pariccheda* II, the Third *Pariccheda* being as it is in other manuscripts.

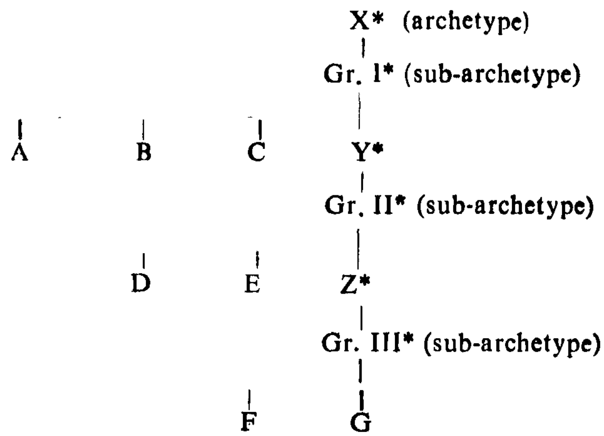
G : Ms. No. R 5151 (a) of the Government Oriental Mss. Library, Madras, described in their *Triennial Cata. of Skt. Mss.*, Vol VI, pp. 7068-69. This is a paper transcript in Grantha characters, copied in 1925-26. from a palmleaf Ms. in Malayalam script belonging to Shri Tuppan Nampūtirippāḍ, Ponnorkottu Mana, Perumbavoor (Kerala). Like Ms. F, here too, *Pariccheda* I is dropped and *Pariccheda* II divided and designated as I and II. The text preserved herein contains a large number of corrupt readings, either because the original Ms. was erratic or the modern scribe did not decipher the writing properly. Obvious errors and wrong decipherments have been ignored in the matter of giving variants in the edition hereinbelow.

Versions of Golasāra

It would be seen from the above that the manuscripts of *Golasāra* resolve themselves into three distinct groups, on the basis of the distribution of verses in the three *paricchedas*, being I : 11, 15, 30 ; II: 20, 6, 30 ; and III: 9, 6, 30. This grouping is corroborated also by the variant readings presented by the manuscripts. From the point of view of contents, the first division, according to which the first *pariccheda* presents the fundamental astronomical constants, the second sets out the situation of the celestial globe and of the planets therein, and the third explains the calculation of the position of the celestial bodies, is the most natural, besides being logical and compact. A mathematician of the stature of Nilakaṇṭha cannot be expected to arrange his work otherwise. This version of *Golasāra*, represented by three of the available manuscripts **A, B** and C, has, therefore, been taken as the basic version in the edition of the text presented here.

It is possible to posit the derivation of Groups II and III from Group I, by manuscript corruption, which should have occurred in two stages : (1) In an exemplar, the colophon of *Pariccheda* I should have been inscribed by the revisor of the manuscript, at the bottom of the leaf (where II. 9 had ended), with due indication of its correct place ; when, however, a copy was prepared from that exemplar, the revisor's indication was unnoticed and the colophon, which was written at the bottom, instead of being inserted properly after I. 11, got attached to II. 9, resulting in the archetype of the Group II manuscripts. Our manuscripts **D** and **E** should have descended from a manuscript of this derivation.

Group III manuscripts, *viz.*, F and G, should have descended from a Group II exemplar in which the first eleven verses were missing. The above-said possible derivation might be represented by the following *stemma codicum* :



The Author

Nīlakaṇṭha is generally referred to with the title *Somayājin*, *Somasut*, *Somasutvan* or *Comātiri*. A detailed colophon occurring at the end of his *Bhāṣya* on the *Gaṇitapāda* of the *Āryabhaṭīya*, contains a good deal of useful information about him : **इति श्री-कुण्डग्रामजेन गार्ग्यगोत्रेण आश्वलायनेन भाट्टेन केरलसद्ग्राम-गृहस्थेन श्री-श्वेतारण्यनाथ-परमेश्वर-करुणाधिकरणभूत-विग्रहेण जातवेदःपुत्रेण शङ्कराग्रजेन जातवेदोमातुलेन दृग्गणितनिर्मापक-परमेश्वर-पुत्र-श्री-दामोदरात्तज्योतिषामयनेन रवित आत्तवेदान्तशास्त्रेण सुब्रह्मण्यसहृदयेन नीलकण्ठेन सोमसुता विरचितविविधग्रन्थेन दृष्टबहूपपत्तिना स्थापितपरमार्थेन कालेन शङ्कराद्य (? य) निर्मिते श्रीमदार्यभटसिद्धान्त-व्याख्याने महाभाष्ये** etc.[1]

Personal Details

Thus, Nilakaṇṭha belonged to the Gārgya gotra, was a follower of the *Āśvalāyana-sūtra* of the *Ṛgveda* and was a *Bhāṭṭa*. He was the son of Jātavedas and had a younger brother named Śaṅkara. He had an uncle Jātavedas by name and a close friend Subrahmaṇya. He was a performer of the *Soma* sacrifice. He had composed several works on Astronomy, in which subject he had made deep and extensive investigations, a fact which is well borne out by his available works.

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1. Ed., *Trivandrum Sanskrit Series*, (*TSS*), No. 101, (Trivandrum, 1930), p, 180.

Some more personal details about Nīlakaṇṭha seem to be forthcoming from a Malayalam work *Laghurāmāyaṇa*.[1] This work describes itself as a work of Rāma, son of Nīlakaṇṭha of Gāryga gotra and resident of Kuṇḍagrāma; *cf.* the colophon at its end : इति कुण्डग्रामजेन गार्ग्यकुलतिलकेन श्री-नीलकण्ठात्मजेन आर्याम्बा-गर्भसम्भवेन मन्वादिस्मृतिमर्मज्ञ-संस्कृत-द्राविडभाषाश्रयपारीणस्य दक्षिणामूर्तिनाम्नोग्रजेन रामेण विरचितं श्रीरामायणम् प्रबन्धम् ।

This Nīlakaṇṭha is identified by the editor of the work with our author.[2] If this identification is correct, Nīlakaṇṭha's wife was named Āryā, and he had two sons Rāma and Dakṣiṇāmūrti, the latter of whom was well versed in the Dharmaśāstras and learned in three languages, Sanskrit, Tamil and Malayalam. The great Malayalam poet Tunchattu Ezhuttacchan is said to have been a student of Nīlakaṇṭha. Nīlakaṇṭha is also said to have composed at the request of a friend a panegyric in Malayalam on the Goddess Pārvatī, the presiding deity of the temple of Ūrakam in Cochin, in order to ward off the predicted premature death of the friend's daughter.[3] The authenticity of the above work and the source of the information are, however, not quite certain, and, so, corroborative evidences have to be found before accepting the above statements.

Birthplace and House

Nīlakaṇṭha hailed from Tṛ-k-kaṇṭiyūr (Sanskritised into Kuṇḍapura or Kuṇḍagrāma), near Tirur, S.Ry., Ponani taluk, South Malabar, a famous seat of learning in Kerala during the middle ages. The name of his *Illam*,—as the house of a Nampūtiri Brāhman is called,-was Keḷallūr (sometimes spelt also as Kerallūr). It is Sanskritised into Kerala-sad-grāma corresponding to the Malayalam word Keraḷa-nal-l-ūr.[4] Nīlakaṇṭha's house is identified with the present Eṭamana

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1. Ed. P.R. Menon, *Tunchattu Granthāvali*, No. 3, Tunchattu Karyalayam, Chittoor, 2nd edn., 1939.

2. *Vide* P.R. Menon, his article 'Tunchattu Ezhuttacchan', in the Malayalam monthly *Tunchattu Ezhuttacchan*, 3 (1952-53) 127-35.

3. *Ibid.* This stotra is published in a collection of stotras in Malayalam script, *Stavaratnamālā*, Pt. I.

4. It may be noted that in the expression *Gārgya-Kerala* prefixed to the author's name, the word *Kerala* refers to the name of his house and not to his country, as is sometimes taken.

Illam, situated a little to the south of the local temple.[1] It is stated that Nilakaṇṭha's family became extinct and the family property was inherited by the nearest *dāyadi* relations, viz., the Eṭamana family.[2]

Nilakaṇṭha's favourite deity was Lord Śiva installed at the famous temple at Tṛpparaṅṅoḍ (Sanskrit Śvetāraṇya) near his village ; *cf.* श्री-श्वेतारण्यनाथ-परमेश्वर-करुणाधिकरणभूतविग्रहेण, in the colophon to the *Ā. Bhāṣya* quoted above, (p. xi).

Śaṅkara, Brother of the Author

Nilakaṇṭha refers to his younger brother Śaṅkara in several places in the *Ā. Bhāṣya.* Śaṅkara too seems to have been well versed in astronomy and followed his elder brother's studies. Thus, after describing some methods on the Rule of three (*Trairāśika*) in his *Ā. Bhāṣya, Gaṇita.* 26, Nilakaṇṭha says how his brother who was giving tuitions at the house of his patron explained to the latter some of those principles ; *cf.* अत्र केषांचिद् युक्तयः पुनः अस्मदनुजेन शङ्कराख्येन तत्समीपे अध्यापयता वर्तमानेन तस्मै प्रतिपादिताः । (*TSS* 101, p. 156).

Nilakaṇṭha observes at the close of his *Bhāṣya* on the *Golapāda* that he was entrusting the *Bhāṣya* to Śaṅkara for its proper propagation. Thus, just before the final colophon, he says : एवमिदम् अस्माभिर्यथामति व्याख्यातम् ।

नमो भगवते तस्मै श्रीमदार्यभटाय च ।
नमः स्वयम्भुवे तस्मै यत्प्रसादादिदं कृतम् ॥
यदि स स्याल्लिप्सेदस्मै दातव्यमेव शङ्कर ते ।
शिष्यं तत्त्वेन विचार्यार्यभटसूत्रभाष्यमिदम् ॥

इति गोलपादव्याख्यानं समाप्तम् ॥

This statement helps also to explain and emend the obscure passage शङ्करायनिर्मिते in the detailed colophon to the work quoted above. Since the *Bhāṣya* was written for his brother Śaṅkara the passage may be read as शङ्कराय निर्मिते ।[3]

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1. *Cf.*, Vatakkumkur Rajaraja Varma, *History of Skt. Lit. in Kerala*, vol. I, (Trivandrum, 1938), p. 354.

2. I am thankful for this information to Sri Rama Varma Maru Thampuran, Chalakkudi (Cochin).

3. *Cf.*. *TSS* 101, p. 180. A variant reading given in the edition as footnote,

Netranārāyaṇa, Patron of Nīlakaṇṭha

That Nīlakaṇṭha was intimately connected to and was patronised by Kauṣītaki Āḍhya Netranārāyaṇa, known locally as Āzhvāñceri Tamprākkal, the religious head of the Nampūtiri Brāhmans of Kerala, is known from several references found in his writings. It is also clear that the patron had great esteem for Nīlakaṇṭha's erudition in astronomy, in which subject he too was interested and used to discuss intricate points with Nīlakaṇṭha. Thus, in the discussion on the calculation of the geocentric motion of planets (*Ārya.*, *Kāla*. 22-25), Nīlakaṇṭha says :[1]

कर्णभुक्तिः स्फुटेत्यत्र व्याख्याने पारमेश्वरे ।
व्यासार्धघ्नं कोटिवर्गात् कर्णवर्गणादाप्तं धनम् ॥

कोट्यां तदूनयुग् व्यासदलं गतिविधौ श्रुतिः ।
प्रकारान्तरमाहैवं सूक्ष्मभुक्तिप्रसिद्धये ॥

गुरूणां मे पितात्रापि स्थौल्यान्मत्सरिणोदिते ।
परमेश्वर-तच्छिष्या नैव वेलागतिं विदुः ॥

इति कौषीतकी श्रुत्वा नेत्रनारायणः प्रभुः ।
मह्यं न्यवेदयत् तस्मै तदेवं प्रत्यपादयम् ॥

Again, in the long discussion on the calculation of the apparent position of celestial bodies (*Ārya.*, *Kāla*. 17-21), speaking on a method to derive the *sakṛt-karṇa*, our author says :[2] **अन्यदपि कर्म अस्माभिरुपन्यस्यमानं श्रुत्वा** आढ्येन कौषीतकिना **अनुष्टुभा निबद्धम्** :

स्वोच्चोनमध्यमार्कस्य भुजाज्याघ्ना त्रिजीविका ।
स्वोच्चहीनस्फुटार्कस्य दोर्ज्याभुक्ता श्रुतिर्भवेत् ॥ इति ॥

This would indicate the intimacy that existed between Nilakaṇṭha and his patron and the common interest that bound them together. On the compilation of the *Ā. Bhāṣya*, Nīlakaṇṭha observes in one place :

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viz., शंकरार्यनिर्मिते makes no sense. It may also be noted that Ulloor (*Kerala Sāhitya Caritram*, vol. II, Trivandrum, 1954, p. 118) takes it to read शंकरार्यनिर्मिते, which is not correct.

1. *TSS* 110, p. 63.

2. *Ibid.*, 47.

यन्मयात्र केषांचित् सूत्राणां तद्युक्तीः प्रतिपाद्य कौषीतकिना आढ्येन नारायणाख्येन व्याख्यानं कारितम्, अतस्तदेव अत्र लिख्यते । (*TSS* 101, p. 113). Again, at another context he remarks : इतीदं प्रथमे वयस्येव वर्तमानेन मया द्वितीयवयसि स्थितेन कौषीतकिना आढ्येन कारितम् । '''तस्मिन् स्वर्गते पुनः''' व्याख्यानमारब्धम् । (*TSS* 101, p. 156).

It is clear from this that the credit of enthusing Nīlakaṇṭha in his investigations, and, in fact, to have prompted him to write his *Bhāṣya*, goes to Netranārayaṇa,[1] the members of whose family are known all through the annals of Kerala history to have been good scholars and at the same time munificent patrons of scholarship.

Nīlakaṇṭha's Teachers : 1. Ravi

Nīlakaṇṭha informs us in his *Bhāṣya* that he studied Vedānta under Ravi, *cf. Ravita atta-vedāntaśāstreṇa*.[2] That Ravi was well versed also in Jyotiśśāstra and that Nīlakaṇṭha imbibed some of his knowledge in astronomy from him is clear from the introductory verse to Nīlakaṇṭha's *Siddhāntadarpaṇa*, where Ravi, his teacher, has been mentioned by *double entendre* :

श्रीमद्दामोदरं नत्वा भगवन्तं रविं तथा ।
यत्प्रसादान्मया लब्धं ज्योतिश्चरितमुच्यते ॥

A work on astrology entitled *Ācāradīpikā*, being a detailed commentary, in verse, on *Muhūrtāṣṭaka* is ascribed to this Ravi.[3]

2. Dāmodra

The regular teacher of Nīlakaṇṭha who initiated him into the science of astronomy and instructed him on the various principles uuderlying mathematical calculations was Dāmodara, son of the Kerala

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1. Even with regard to Nīlakaṇṭha's *Tantrasaṅgraha*, its introductory verse,

हे विष्णो निहितं कृत्स्नं जगत् त्वय्येव कारणे ।
ज्योतिषां ज्योतिषे तस्मै नमो नारायणाय ते ॥

seems to have a veiled reference to his patron (Netra)-Nārāyaṇa at whose instance this work too seems to have been written.

2. *Cf.*, the detailed colophon quoted above, on p. xi, from *TSS* 101, p. 180.

3. Ulloor, *Kerala Sāhitya Caritram*, vol. II, p. 114. For a ms. of this work, see Kerala Uni. Mss. Lib., 3336-B.

Dṛggaṇita author Parameśvara,[1] of the Bhārgavagotra and resident of the village of Ālattūr (Sanskritised into Aśvatthagrāma) which was situated quite near Nīlakaṇṭha's own village. In his *Ā. Bhāṣya*, as also in his other works, Nīlakaṇṭha reverentially refers to his teacher and his studies under him. He speaks of how even as a boy he stayed with his *guru* at the latter's residence prosecuting his studies ; *cf.* मया गुरुकुले वसता बाल्य एव etc. (*Ā. Bhāṣya, TSS* 110, p. 48). He also refers, often, to his teacher's views and quotes him : *cf.* प्रकारान्तरेण 'चन्द्रबाहुफलवर्ग'त्याविना श्रीमद्-दामोदराह्वयाद् गुरुमुखोद्गतेन श्लोकेनोक्ता तद्युक्तिः etc. (N's unidentified work[2] in the Trivandrum Palace Library, Ms. No. 975, transcript, p. 61) ; तच्चोक्तमस्मदाचार्यैः (*Ā. Bhāṣya, TSS* 101, p. 47) ; निबद्धं च तत् तत्रैव अस्मद्गुरुभिः पञ्चभिरुपजातिभिः "अर्कस्फुटेनानयनं प्रकुर्यात् etc." (*ibid.*, p. 48); तदपि—

"सर्वत्र विष्कम्भदलं श्रुतौ वा व्यासार्धके स्याद् विपरीतकर्णः ।"

इत्यस्मद्गुरुणोक्तम् । (*Siddhāntadarpaṇa-vyākhyā*, on verse 27, Ms. Trivandrum Palace Library, No. 975 ; transcript, p. 30).

Similar quotations and other references, which Nīlakaṇṭha and later authors make, proclaim Dāmodara not only as a prominent astronomer of the times but also as the author of erudite works on the subject, manuscripts of which, however, are yet to come to light. An astrological work *Muhūrtābharaṇa* is sometimes attributed to this Dāmodara.[3] But it has been shown[4] that this ascription is wrong since it is clear from the introductory verses of this work that this Dāmodara was the son[5] of Keśava of the *Bhāradvāja*-gotra, while our Dāmodara is the son of Parameśvara of the *Bhārgava*-gotra.

Nīlakaṇṭha and Parameśvara

Nīlakaṇṭha followed in the footsteps of Parameśvara, founder of the Dṛggaṇita system of astronomy in Kerala and one of the

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1. *Cf.*, the detailed colophon quoted above, on p. xi, from *TSS* 101, p. 180.

2. On this work see below.

3. *Cf.*, Vatakkumkur, *History of Sanskrit Literature in Kerala*, I. 388 ; K. Sambasiva Sastri, Introduction his edn. of *A. Bhāṣya*, *TSS* 101, Intro., p. 6.

4. *Cf.* K. Mahadeva Sastri, Preface to the *Descriptive Catalogue of Sanskrit Manuscripts in the Curator's Office*, Trivandrum, vol. V, Preface, p. iii-vi ; Ulloor, *Kerala Sāhitya Caritram*, vol. II, p. 106.

5. Brother, according to Ulloor's quotation of the particular verse, *cf. Kerala Sāhitya Caritram*, vol. II, p. 106.

foremost astronomers of the land. For him Parameśvara was not only the revered father of his *guru* but was also his *Parama-Ācārya*, by which term he generally refers to him in his works ; *cf.* यतो भार्गव-परमेश्वराचार्येण अस्मत्परमगुरुणा 'चलांशास्स्वं' (4536) इति कल्यब्दे परीक्ष्य पञ्च-दशांशपूर्तिर्निर्णीता । etc, (*Siddhāntadarpaṇa-vyākhya*, verse 18) ; अस्मत् परमगुरुणापि सिद्धान्तदीपिकायाम् एतत् प्रतिपादितम् (*Ā.Bhāṣya, Golapāda*, verse 3, *TSS* 185, p. 13).

It also seems that though Nilakaṇṭha had his regular study under Dāmodara, he had personally known Parameśvara and that the latter had instructed him on certain matters. Thus, in his *Ā. Bhāṣya, Gola.* 11, (*TSS* 185, p. 27) he quotes a line from Parameśvara's *Goladīpikā* (3.35) with the prefatory note : *ata evoktam asmadācāryeṇa Goladīpikāyām.*

Works of Nilakaṇṭha

Nilakaṇṭha has written several works which reflect his deep study and ripe scholarship in astronomy, embodying the result of his investigations in the subject and interpreting the science lucidly. A mention of his works may, advantageously, be made here.

1. *Golasāra* in three *paricchedas*, being the work edited here.

2. *Siddhāntadarpaṇa*,[1] a short work in thirty-two *anuṣṭubhs*, indicating the astronomical constants with reference to the *Kalpa* and specifying his views on the main astronomical conceptions and topics on which there are differences of opinion among authorities.

3. *Candracchāyāgaṇita*,[2] or merely *Chāyāgaṇita* under which title it is generally cited, a short work in thirty-one verses on the methods for the calculation of the moon's shadow and of the time during night on the basis of the shadow.

4. A commentary on the *Candracchāyāgaṇita*[3] above, elucidating clearly the principles and methods enunciated by him in the text.

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1. Critically ed. with Translation by the present writer, Adyar Library, Madras, 1955. Two short anonymous tracts, entitled *Siddhāntadarpaṇasiddha-paryayādayaḥ* and *Siddhāntadarpaṇastha-paryaya-bhūdināni*, added as Appendices to this edition, vouch for the popularity of this text.

2 Mss. : Kerala Uni. 5862-B, Madras R. 5185 (b).

3. Mss. : Kerala Uni. 5862-B, Madras R. 5185 (b).

5. *Tantrasaṅgraha*[1] divided into eight chapters comprising 432 verses. This is a major work of Nīlakaṇṭha and is an erudite treatise on astronomy. As a work belonging to the Tantra class, it takes the commencement of the Yuga as the starting point for calculations. In the several chapters it deals with : I. Astronomical constants and general principles and conceptions. II. Calculation of the geocentric positions of the planets. III. The gnomon and calculations therewith. IV. Eclipses of the Moon and the Sun. V. Specialities in the Sun's eclipse. VI. *Vyatīpāta*. VII. The Phases of the Moon etc. VIII. *Śṛṅgonnati* of the Moon. It may be specially noted that unlike some Kerala authors who treat both the *Parahita* and *Dṛk* systems in their works, Nīlakaṇṭha treats here only of the *Dṛk* system, of which he was a great protagonist.

6. *Āryabhaṭīya-Bhāṣya*,[2] an elaborate commentary on the cryptic and sūtra-like text of Āryabhaṭa which comprehends in 121 *āryās* the fields of mathematics and astronomy. A perusal of the commentary will amply prove that it is no false claim that Nīlakaṇṭha makes when he designates his work as a '*mahābhāṣya*' and explains the method of exposition adopted by him : श्रीमदार्यभटाचार्यविरचित-सिद्धान्तव्याख्याने महाभाष्ये उत्तरभागे युक्तिप्रतिपादनपरे त्यक्तान्यथाप्रतिपत्तौ निरस्तदुर्व्याख्याप्रपञ्चे समुद्घाटितगूढार्थे सकलजनपदजातमनुजहित-निदर्शितगीतिपादार्थे सर्वज्योतिषामयन-रहस्यार्थ-निदर्शके समुदाहृत-माधवादिगणितज्ञाचार्यकृत-युक्तिसमुदाये निरस्ताखिलविप्रतिपत्तिप्रपञ्च-समुपजनित-सर्वज्योतिषामयनविदमलहृदय-सरसिजविकासे निर्मले गम्भीरे अन्यूनातिरिक्ते गणितपाद-गतार्यात्रयस्त्रिंशद्व्याख्यानं समाप्तम् ॥ (*TSS* 101, p. 180).

In another context, reminiscising how he came to write the commentary, Nīlakaṇṭha remarks : मयाद्य प्रयसा ज्ञाता युक्तीः प्रतिपादयितुं भास्करादिभिरन्यथाव्याख्यातानां कर्माण्यपि प्रतिपादयितुं यथाकथंचिदेव व्याख्यानमारब्धम् ॥ (*TSS* 101, p. 156). The lucid manner in which the difficult conceptions about the celestial globe and astronomical calculations are made clear, the wealth of quotations and the results of personal investigations and comparative study presented therein amply justify the appellation '*mahābhāṣya*' which Nīlakaṇṭha gives to his work.

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1. Ed. with commentary *Laghuvivṛti* of Śaṅkara Vāriyar, Trivandrum, 1958, *TSS* 188. This work has another incomplete commentary, in verse, by a Brahman of the Parakroḍa village (Mal. Tṛ-p-paraṅṅod) near Nīlakaṇṭha's own native place.

2. Ed. *TSS* 101, 111, 185 (Trivandrum, 1930, 1931, 1957).

Nilakaṇṭha has commented only on the *Gaṇita*, ***Kālakriya*** and *Gola pādas* of the *Āryabhaṭīya*, leaving out the ***Gītikāpāda***, which he says is covered by the commentary on the other three sections; *cf.* तत्रेयं त्रिपाद्यस्माभिर्व्याचिख्यासिता, यतस्तद्व्याख्येयरूपत्वाद् गीतिकापादस्य एतद्व्याख्यानेनैवार्थः प्रकाशेत' (*TSS* 101, p. 1).

7. *Siddhāntadarpaṇa-vyākhyā*, a commentary by Nīlakaṇṭha on his own *Siddhāntadarpaṇa*, of which only an incomplete Ms. is available.[1] The commentary is elaborate and resembles, in diction and treatment, his *Āryabhaṭīya-bhāṣya*. It is in this work that Nīlakaṇṭha gives the actual date of his birth (see below).

8. *Grahaṇanirṇaya*, a work on the computation of lunar and scolar eclipses, possibly a short text in verse, like his other shorter works. Manuscripts of this work are yet to be discovered, but later authors and Nīlakaṇṭha himself in his *Ā. Bhāṣya* quote from this work; *cf.* तदैव ग्रहणमध्यं च । स्फुटसाम्ये तु विक्षेपकोटिमण्डलापक्रमण्डलयोः भुक्तभागसाम्यमेव स्यात् । तदुक्तं मया ग्रहणनिर्णये –

परमक्षेपकोटिघ्नः पातोनार्कभुजागुणः ।
स्वेष्टविक्षेपकोट्याप्तस्तत्क्षेपकृतियोगतः ॥

एवं यच्चापितं यच्च पातोनार्कभुजाधनुः ।
तद्विशेषं हृतं षष्ट्या गत्यन्तरहृतं क्षिपेत् ॥

पर्वान्तेऽयुक्पदे क्षेपः शोधयेद् विषमे पदे ।
एवं कृतोऽपि पर्वान्ता सूर्येन्द्वोर्ग्रहणे स्फुटम् ॥

(On *Golapāda*, 44, *TSS* 185, p. 102)

These verses are quoted also by Śaṅkara in his commentary on Nīlakaṇṭha's *Tantrasaṅgraha* (on IV. 27, *TSS* 188, p. 167) with the introductory remark तदुक्तमनेनैव ग्रहणनिर्णये ।

9. *Sundararājapraśnottara*. Sundararāja, son of Anantanārāyaṇa was an astronomer of the Tamil country contemporaneous with Nīlakaṇṭha and author of a detailed commentary on *Vākyakaraṇa* or *Vākyapañcādhyāyī* which is the basic manual on which almanacs in

1. Ms. 975 of the Trivandrum Palace collection of mss., now preserved in the Kerala University Mss. Library. The references to pages are to a transcript supplied to me by the Palace authorities.

the Tamil districts are computed [1] Sundararāja had the greatest respect for Nīlakaṇṭha[2] whom he addressed for clarification of certain points in astronomy. Nīlakaṇṭha's detailed answers to these questions formed a regular work, *Sundararājapraśnottara*. Manuscripts of this work are yet to come to light, but both authors refer to this work. *Sundararāja* in his commentary on *Vākyakaraṇa*, V. 19, says :[3]

अत्र तु गतियोगांशकेनैव हरणं युक्तमिति श्रीमत् केरलभद्गामनिवासि-नीलकण्ठार्येण त्रिस्कन्धविद्यापारदृश्वना षड्दर्शनीपारंगतेन आश्वलायनसूत्रेण गार्ग्यगोत्रेण नवकलरु (?) जातेन गोलचूडामणिना अस्मदनुग्रहार्थं सुन्दरराजप्रश्नोत्तराख्ये ग्रन्थे प्रतिपादितम्। तेन गतियोगेनैव विभज्य स्थितिदलं ज्ञेयम्।

Nīlakaṇṭha too has a long quotation from this work in his *Ā. Bhāṣya*, *Gola*. 48, which he introduces with the words : सुन्दरराजप्रश्नोत्तरे **मयोक्तमप्यत्रानुसन्धेयम्** । (*TSS* 185, p. 149).

10. A *Grahaṇa-grantha*, written in continuation of Nīlakaṇṭha's *Siddhāntadarpaṇa-vyākhyā* in the Trivandrum Palace manuscript No, 975.[4] The work as available in this manuscript begins '**अथ ग्रहणम्**' and without any more introduction continues : **नन्वेवमपि स्वकाल एव गीतिकोक्तभगणाद्याः गीतस्य ग्रहणस्य (च) प्रत्यक्षसंवाद स्यात्** । It goes on to describe the necessity of correcting old astronomical constants by observation, deals in detail with the *Śakābda-saṁskāra*, quotes the verses of his *Parama-guru* Parameśvara from his *Siddhāntadīpikā* (*Mahābhāskarīya-bhāṣya-vyākhyā*)[5] on the latter's observation of some eclipses, and after some more discussions ends abruptly. There is no doubt that this work is from Nīlakaṇṭha's pen. References to his own works, teacher etc. fully confirm this point. One of his own works is referred to in the passage thus : **अत एव मया** छायागणिते **तत्साधनतया दृक्क्षेपानयनमुक्तम्**— '**अन्त्यद्युज्या**' etc. (p. 60 of the transcript). The verses quoted are from

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1. Ed. critically by T.S. Kuppanna Sastri and K.V. Sarma, K.S.R. Institute, Madras, 1962.

2. He even commences his work expressing his respect for Nīlakaṇṭha ; *Cf.*, his second introductory verse, which begins : *Śrī-Nīlakaṇṭhāṅghri-niviṣṭacetāḥ* (*ibid.*, p. 1).

3. *Ibid.*, p. 119.

4. The page references, below, refer to the transcript of the manuscript supplied to me.

5. Ed. by T.S. Kuppanna Sastri, *Madras Govt. Or. Ser.* 130 (1957).

Nilakaṇṭha's available work, *Candracchāyāgaṇita*, vv. 8-10. He refers to his grand-teacher Parameśvara and his *Ā. Bhāṣya*, too, herein: तस्मात् सिद्धान्तदीपिकोदाहृतानि ग्रहणान्यस्माभिर्दृष्टानि च तत्तदवसरे वक्ष्यमाणानि परमेश्वरोक्तप्रकारेण अर्कविम्बयममानीय श्रीपत्युक्तप्रकारेण स्फुटीकृत्य कालक्रिया-गोलपादोक्ताभिरस्माभिर्व्याख्याताभिः युक्तिभिः सिद्धैः क्रियाविशेषैश्च गण्यन्ताम्। (p. 57-58 of the transcript). The *Ā. Bhāṣya* is referred also elsewhere in this work (*cf.* pp. 62, 63 of the transcript). For a characteristic reference to his teacher see: प्रकारान्तरेण 'चंद्रबाहुफलवर्ग' त्यादिना श्रीमद्-दामोदराह्वयास्मद्गुरुमुखोद्गतेन श्लोकेनोक्ता तद्युक्तिरपि आर्यभटीयान्तर्भूतैव। (p. 61 of the transcript). This *Grahaṇa-grantha*, which is primarily a treatise in prose, does not contain the verses quoted above from the *Grahaṇanirṇaya* which is obviously a different work.

11. *Grahaparīkṣākrama* (?). The well-known Kerala astrologer Puliyūr Purushottaman Namputiri has edited[1] an old, incomplete[2] Malayalam summary of a Sanskrit work under the title *Grahaparīkṣā-kramam.* The textual verses were not available to the editor and he presumed the author to be Dṛggaṇita-Parameśvara.[3] These verses are, however, found in Nilakaṇṭha's *Bhāṣya* on the *Golapāda* of the *Ārya-bhaṭīya*, under verses 48 (*TSS* 185, pp. 132-49). It is a long tract of about 200 verses, summing up the principles and methods followed in Indian astronomy and forms a veritable handbook an the subject, and ends:

इति संक्षेपतः प्रोक्ता परीक्षा ज्योतिषामिह ।
कालमानचतुष्कस्य श्रुतस्य विवृतिस्त्वियम् ॥

It is not however definite whether this is an independent work with the title *Grahaparīkṣākrama* and quoted in extenso in the *Bhāṣya* or only forms a part of the *Bhāṣya*; the ascription of this as a separate work of Nilakaṇṭha has therefore to remain tentative till it is supported by independent manuscript or other evidence.

Nilakaṇṭha should have written more works than those detailed above, since there are quotations attributed to him in later works,

1. Pub. by the Astrological Research Institute, Bombay-25, 1950.

2. The colophonic words at the end of the edition indicating its completion is only the editor's addition.

3. Vide the editor's Introduction, p. i; see also Shri Namputiri's review and opinion of *Gaṇitaprakāśika* by K. V. A. Rama Poduval, Canannore, 1950, p. xiv.

for instance, in Śaṅkara's commentary *Laghuvivṛti* on his (N's) *Tantrasaṅgraha*, which cannot be traced to his known works. Again, the Trivandrum Palace Ms. No. 975 containing Nīlakaṇṭha's *Siddhāntadarpaṇavyākhyā* and the work on eclipses described above, has, in continuation, some incomplete tracts with no definite titles, which again, to all appearances, seem to be Nīlakaṇṭha's writings.

The *New Catalogus Catalogorum* (Madras Univ., vol. V, p. 262a) records a Ms. of *Gaṇitadarpaṇa* by Nīlakaṇṭha (*Travancore Ad. Rep., 1104*, 75). Probably, this is only his *Siddhāntadarpaṇa*. According to some,[1] Nīlakaṇṭha has composed a *Grahanirṇaya*; it is likely, however, that this is only the *Grahaṇanirṇaya* noticed above. Ulloor attributes to Nīlakaṇṭha a work called *Gaṇitayukti*: Thus, speaking about a *Bhāṣāyuktibhāṣa*, he says that "it is not the work of Kelallūr Comātiri, author of *Gaṇitayukti*."[2] This ascription is wrong and the fact is that while our author belonged to the Garga-gotra, this latter work is by an anonymous author belonging to the Bharadvāja-gotra, as is clear from its first verse, which runs as follows :

विदित्वार्यभटप्रोक्तगोलतत्त्वेन केनचित् ।
भारद्वाजेन तन्यन्ते काश्चित् गणितयुक्तयः ॥[3]

Chronology of Nīlakaṇṭha's Works

It has already been pointed out by other scholars[4] that Nīlakaṇṭha's *Ā.Bhāṣya* is later than his *Tantrasaṅgraha* and *Golasāra* which are quoted in the former. But nothing could be said about the chronology of his other works. It is possible, however, to shed some light on this matter.

The first five works enumerated above, *viz.*, *Golasāra*, *Siddhāntadarpaṇa*, *Candracchāyāgaṇita*, the commenary thereon, and *Tantrasaṅgraha* do not refer to any other work but are, in their turn, quoted in other works of Nīlakaṇṭha. Of these, the *Tantrasaṅgraha* is the most comprehensive of the five and gives the date of its composition as 1500 A.D., *i.e.*, written when the author was

1. *E.g.*, Vatakkumkur, *Hist. of Skt. Lit. in Kerala*, vol. I, p, 389 ; Ulloor, *Kerala Sāhitya Caritram*, vol. II, p. 117.

2. Ulloor, *ibid.*, p. 122.

3. Ms. : Madras, Mal. D. 339, pp. 83-89. Kerala Uni. Ms. 755.

4. Ulloor, *Kerala Sāhitya Caritram*, vol. II, p. 119.

fifty-six, and on these considerations it may be presumed that the other four works were written before it. The *Grahaṇanirṇaya* and the *Sundararājapraśnottara*, of which manuscripts have yet to be discovered and which are quoted in the *Ā.Bhāṣya*, have also to be ascribed to this period. This *Bhāṣya*, his mature work, Nīlakaṇṭha wrote when he was old, as he himself remarks : मयाद्य प्रवयसा ··· यथाकथंचिदेव व्याख्यानमारब्धम् । (*TSS* 101, p.156). The *Siddhāntadarpaṇa-vyākhyā* which refers to the *Āryabhaṭīya-Bhāṣya* (*cf.* on verse 25 : एतत् सर्वं मया आर्यभटीयव्याख्याने प्रपञ्चितमिति विरम्यते । p.22 of the transcript) is still later. And so also is his discursive treatise on eclipses which too refers to the *Ā. Bhāṣya* more than once : *cf.* तत्र कालक्रियापादे सूचितं मया विवृतम् (p. 63 of the transcript) ; एतत् सर्वं गणितपादे विस्तरेणोपपादितः (*ibid.*, p. 63).

Date of Nīlakaṇṭha (A D. 1443-1545)

Indisputable evidences are available regarding the date of our author. Śaṅkara, Nīlakaṇṭha's pupil, in his commentary on his teacher's *Tantrasaṅgraha*, points out that the first and last verses of that work contain chronograms specifying the dates of commencement and completion of the work. Thus, after giving the natural meaning of the first verse :

'हे विष्णो निहितं कृत्स्नं' जगत् त्वय्येव कारणे ।
ज्योतिषां ज्योतिषे तस्मै नमो नारायणाय ते ॥

Śaṅkara says : आचार्येण इमं श्लोकं आदितो ब्रुवता प्रथमपादेन प्रबन्धारम्भ-दिनवत्यहर्गणश्च अक्षरसंख्यया उपदिष्टः, समाप्तिसमयाहर्गणश्च 'लक्ष्मीशनिहितध्यान' इत्यन्ते भविष्यति । These two Kali dates 16,80,548, and 16,80,553 work out to Kali year 4601, Mīna 26, and 4602, Meṣa 1, both dates occurring in April 1500.

The *Siddhāntadarpaṇa* and Nīlakaṇṭha's own commentary thereon give the year and actual date of his birth : *cf.*

कलिसन्ध्यष्टमांशे स्वशतांशाढ्ये गते ततः ।
धनुर्मिथुनयोर्मध्ये प्रायशस्त्वयने उभे ॥

(*Siddh. Dar.* verse 18)

N's Com. दिव्याब्दशतमिता खलु काले सन्ध्या स्मर्यते । तस्य अष्टमांशः सार्ध-दिव्याब्दद्वादशकः । स च सौराब्दानां पञ्चचत्वारिंशत्शतमितः (4500) । तस्य शतांशः

पञ्चचत्वारिंशदब्दः (45) । ततः स्वशतांशाढ्यः 'शिवशिवे'ति (4545) कल्यब्दैस्तावति याते उभे अयने उत्तरदक्षिणाख्ये प्रायशो धनुमिथुनमध्ये स्तः । तदा अयनचलनांशाः धनात्मकाः पञ्चदशसंख्या बभूवुः । प्रायिकत्वं च कलाष्टकाधिकत्वात् । यतो भार्गव-परमेश्वरार्येण अस्मत्-परमगुरुणा 'चलांशास्स्त्रं' (4536) इति कल्यब्दे परीक्ष्य पञ्चदशांशपूर्तिर्निर्णीता । अतः सन्ध्याष्टमांशशतांशस्य प्रायिकत्वम् । स्वजन्मकालज्ञापनार्थं चैवमुक्तम् । तदा अहर्गणश्च 'त्यजाम्यज्ञतां तर्कैः' (16,60 181) इति । (p. 14 of the transcript). Here, Nilakaṇṭha himself says that he was born on the Kali date 16, 60, 181, which works out to A. D. 1443 Dec. (Kali 4545 Vṛścika).

That Nīlakaṇṭha lived to a ripe old age, even to be a centenarian, is attested by a contemporary reference made of him in a Malayalam work on astrology, *viz.* the *Praśnasāra* by Mādhava, a Nampūtiri brahman of the Īñcakkāzhvā house in Kerala, who wrote his work in A. D. 1542-43. Here, Mādhava says that he could count upon reputed authorities like 'Keḷanallūr' to recommend his work : cf.

āl-āyat-ādaravil ādiyil Attimattam
lōkōttaran punar-itinniha Keḷanāllūr |
ābhāsar allarivatuḷḷavar ādarippān
porum prasiddhi perikoḷḷavar uṇṭanekam ||

The date of composition of this work is given as Kali 4644 (A. D. 1542-43) by the following verse in the work itself :

ezhunūttorupatteṭṭāvatu Kollam atāya nāl |
varunna viṣuvad 'bhavatattvam' (4644) *kalyabdam āyatu ||*

Rightly does Nīlakaṇṭha remark in his *Ā.Bhāṣya* : मयाद्य प्रवयसा ·· यथाकथंचिदेव व्याख्यानमारब्धम् । (*TSS* 101, p. 156) ; and we know of at least two more works, his commentary on the *Siddhāntadarpaṇa* and the work on eclipses, which quote the *Ā.Bhāṣya*, and which he should have written when he was still older.

Versatility of Nīlakaṇṭha

For a mere Jyautiṣika and one who had specialised only in the astronomical side of it, Nīlakaṇṭha seems to be very well read. Every page of his writings substantiate his knowledge of the several branches of Indian philosophy and culture. Sundararāja, the Tamil astronomer, calls him *ṣaḍ-darśanī-pāraṅgata*, one who

had mastered the six Darśanas[1] Nilakaṇṭha himself informs us that he studied Vedānta under Ravi : *cf. Ravita ātta-vedāntaśāstreṇa*. He can refer to a Mīmāṁsā authority to establish a mathematical point[2] and, with equal facility, use a grammatical dictum for the same purpose.[3] Piṅgala's *Chandassūtra*[4] and the lexicons, he quotes as the occasion demands. The scriptures and the Dharmaśāstra texts also come in for citation.[5] And, also the Purāṇas[6] like the *Bhāgavata*[7] and the *Viṣṇu*.[8] As for Jyotiṣa works, Nilakaṇṭha exhibits a surprising familiarity with a large number of them, from the *Vedāṅga-Jyotiṣa* down to contemporary treatises. He uses all types of jyotiṣa texts, *Gaṇita*, *Saṁhitā* and *Horā*, but as became his subject of specialisation, his quotations are mainly from texts dealing with astronomy proper. Some of the more important texts of all-India prevalence that Nilakaṇṭha quotes are : *Vedāṅga-Jyotiṣa*, *Āryabhaṭīya*, the *Gargasaṁhitā*, *Brahmasiddhānta*, *Varāhamihira's Pañcasiddhāntikā*, *Bṛhajjātakā* and *Bṛhatsaṁhitā*, the *Sūryasiddhānta*, Śrīpati's *Siddhānta-śekhara* and Muñjāla's *Laghumānasa*. Of texts common only in Kerala may be mentioned the *Parahitagaṇita* or *Grahacāranibandhana* of Haridatta,[9] Bhāskara's *Bhāṣya* on the *Āryabhaṭīya* and his *Laghu-* and *Mahā-bhāskarīya-s*, Govindasvāmin's *Bhāṣya* on the latter and Parameśvara's super-commentary *Siddhāntadīpikā* thereon. Other works of Parameśvara like his *Āryabhaṭīya-vyākhya*, *Dṛggaṇita* and *Goladīpikā* also

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1. *Cf.*, his commentary on the *Vākyakaraṇa*, V. 19 (edn., p. 119).

2. *Cf.*, *Ā. Bhāṣya*, *TSS*, 101, pp. 54, 158, *TSS* 185, p. 30 where Pārthasārathi Miśra's *Vyāptinirṇaya* and *Advaitavivaraṇa*, and *Ajitā* (com. on *Ślokavārttika*) and its commentary *Vijayā* come in for quotation. On *Golapāda* 50 (*TSS* 185, pp. 161-64), are quoted the *Ślokavārttika* and *Bṛhaṭṭīkā* of Kumārila, the *Niruktavārttika* of Padmpāda, Manu and Vyāsa.

3. For quotations from the *Vākyapadīya*, see *Ā.Bhāṣya*, *TSS* 110, p. 31.

4. See *Ā.Bhāṣya*, *TSS* 101, p. 4.

5. See Com. on *Siddhāntadarpaṇa*, verse 1, the Grahaṇa work, pp. 48, 49, and *Ā.Bhāṣya*, *Golapāda*, verse 48, where the *Taittirīyopaniṣad*, *Kālanirṇaya* of Sāyaṇa, Manusmṛti etc. are quoted.

6. See Com. on *Siddhāntadarpaṇa*, verse 1.

7. *Cf.*, *Ā.Bhāṣya*, *TSS* 110, pp.16, 26.

8. *Cf. ibid.*, p.8.

9. Ed. K.V. Sarma, K.S.R. Institute, Madras, 1954.

come in for citation as also passages from his own teacher Dāmodara. Another Kerala author whom Nilakaṇṭha quotes profusely is Mādhava, often styled 'Golavid' who was a reputed astronomer of the times.[1] Manuscripts of several works quoted by Nilakaṇṭha are yet to be unearthed. A detailed study of the numerous authorities quoted by Nilakaṇṭha is bound to throw much light on the history of Indian astronomy.

Acknowledgements

The present edition of *Golasāra* had been made possible by the kind co-operation extended by the authorities of the three institutions, to wit, the Kerala University Or. Res. Institute and Mss. Library, Trivandrum, the India Office Library, London, and the Govt. Or. Mss. Library. Madras, and by Shri Rama Varma Maru Thampuran, Chalakkudi (Cochin, Kerala), who made available to me the manuscripts of the work in their possession or supplied collation sheets of the variant readings. I am extremely thankful to them all in the matter. To Prof. T.S. Kuppanna Sastri, lately of the Presidency College Madras, I am particularly indebted for his help in the edition and translation of the work. I also wish to place on record the help I received from Shri Raj Kumar and Shri Tek Chand Vijh of our General Indological Research Department in the matter of reading the proofs and seeing the work through the Press.

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1. On this Mādhava (*c*. 1340-1425), who was a teacher of Dṛggaṇita-Parameśvara, see the present writer's Introduction to his edition of Mādhava's *Veṇvāroha* (Sanskrit College, Trippunithura, Cochin, 1957).

गार्ग्य-केरल

नीलकण्ठ-सोमयाजि-विरचितः

गोलसारः

QUINTESSENCE OF SPHERICAL ASTRONOMY

By Gārgya-Kerala

NĪLAKAṆṬHA SOMAYĀJI

QUINTESSENCE OF SPHERICAL ASTRONOMY

By Gärgya-Kerala

NILAKAṆṬHA SOMAYĀJI

SECTION ONE

(Salutation)

1. Hail Earth, spherical in shape, supporter of all, itself unsupported, around which revolves incessantly the celestial sphere.

(Civil days and Revolutions of the Planets)

2-5a. The Terrestrial days occurring in one-tenth of an Aeon (*Mahāyuga*) are 15,77,91,750. The (number of) revolutions, (during the same period), of the Sun and other (planets), and of the Apogee and Ascending Node of the Moon (*indu-ucca* and *indu-pāta*) are respectively :

(Sun)	4, 32, 000
(Moon)	57, 75, 332
(Mars)	2, 29, 686
(Mercury)	17, 93, 704
(Jupiter)	36, 418
(Venus)	7, 02, 227
(Saturn)	14,660
(Moon's Apogee)	48, 812
(Moon's Node)	23, 230

These (numbers) are enunciated by deduction.

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गोलसारः

प्रथमः परिच्छेदः

[मङ्गलाचरणम्]

गोलाकारा पृथ्वी[1] सर्वाधारा स्वयं निराधारा ।
ज्योतिर्गोलः[2] परितो यामेव सदा भ्रमति[3] सा जयति ॥ १ ॥

[भूदिनानि ग्रहभगणाश्च]

विष्णुपदार्था[4]त्यष्टयङ्काद्रिस्वरशर[5]भुवो दिनानि भुवः ।
युगदशमांशभवान्यथ सूर्यादी[6]न्दूच्चपातभगणाश्च ॥ २ ॥

खत्रयदन्ताम्बुधयो, यमाग्निपुष्करशरर्षिशैलशराः ।
षडहिषडङ्काकृतयो, वेदखमुनिपुष्कराङ्कशैलभुवः ॥ ३ ॥

धृत्यब्धिरसहुताशाः, शैलाकृत्यश्विविष्णुपदमुनयः ।
वियदङ्ग[7]तर्कमनवो, यमचन्द्रगजाहिवारिधयः ॥ ४ ॥

गगनाग्निदन्तयमलान्येते युक्त्या समुद्दिष्टाः ।

Mss. used : A. KU-C 1024 E ; B. KU 8358 E ; C. IO 6301 ; D. KU-C 1869 B ; E. Ms. from Shri Rama Varma Maru Thampuran, Cochin ; F. KU 5867 B ; G. GOML, Madras, R 5151a.

1. E पृथिवी
2. D गोलाः
3. D भ्रमन्ति
4. E om. र्था
5. A. C रा, corrupt.
6. A. B दि for दी, corrupt.
7. E दङ्क, corrupt.

(Positions of the Higher Apses)

5b-6a. (The following are) the positions of the Higher Apses (*Mandocca*) (of the planets) other than the Moon, in degrees: (Sun) 78°, (Mars) 127°, (Mercury) 220°, (Jupiter) 62°, (Venus) 80°, (Saturn) 240°.

(Positions of the Ascending Nodes)

6b. (The following) multiplied by 10 are, respectively, the positions in degrees of the Ascending Nodes (*Pāta*) of the planets beginning with Mars: (Mars) 4 (x 10=40°), (Mercury) 2 (x 10=20°), (Jupiter) 8 (x 10=80°), (Venus) 6 (x 10=60°), (Saturn) 10 (x 10=100°).

(Maximum Mean Latitudes of planets)

7a. (The following) multiplied by 10 give the Maximum Latitudes (of the planets) in minutes: (Moon) 27 (x 10=270'), (Mars) 9 (x 10=90'), (Mercury) 12 (x 10=120'), (Jupiter) 6 (x 10=60'), (Venus) 12 (x 10=120'), (Saturn) 12 (x 10=120').

(Epicycles of the Equation of Apses of the planets)

7b. (The following give in units),[1] the magnitude of the circumference of the *Manda* circles (of the planets beginning) from the Sun: (Sun) 3, (Moon) 7, (Mars) 16, (Mercury) 14, (Jupiter) 8, (Venus) 3, (Saturn) 10.

(Epicycles of the Equation of Conjunction of the planets)

8. (The following give, in units), the magnitude of the circumference of the *Śīghra* (Epicycle of the Equation of Conjunction of the planets) beginning with Mars, (in the odd quadrants): (Mars) 53, (Mercury) 31, (Jupiter) 16, (Venus) 59, (Saturn) 9.

(The same) reduced, respectively, by 2, 2, 1, 2 and 1 are the same in the even quadrants. (*i.e.*, Mars 51, Mercury 29, Jupiter 15, Venus 57, Saturn 8).

(Diameters of the Sun, the Moon and the Earth)

9. The diameters of the Sun, the Moon and the Earth in yojanas as given by the learned are: (Sun) 4410, (Moon) 315, and (Earth) 1050.

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1. The epicycles are given in a unit that makes the circle equal to 80 parts. (See v. 11 b, below). Thus, when the circle is measured in degrees, the unit of measurement for the epicycles in $4\frac{1}{2}$ degrees.

[मन्दोच्चानि]

गजशैला:[1], शैलार्का:, खाकृतयो, द्व्यङ्ग[2]भुव:, खमातङ्गा: ॥ ५ ॥

खजिना, मन्दोच्चांशा विविधूनां;

[ग्रहाणां पातस्थानानि]

पातभागास्तु ।

जलधि,-[3]यमा-ऽहि,-रस,-दिशो दशाहता भूमिजादीनाम् ॥ ६ ॥

[परमविक्षेपा:]

[4]तारा,-ऽङ्क,-रवि,-रसा,-ऽर्का:, प्रभाकरा: क्षिप्तिलिप्तिका विघ्ना: ।

[मन्दवृत्तपरिधय:]

[5]सूर्यान्मृदुवृत्तांशा: त्र्य-ऽश्वा-ऽष्टी न्द्रा-ऽहि-रामा-ऽऽशा: ॥ ७ ॥

[शीघ्रवृत्तपरिधय:]

शैघ्रे भौमादीनां गुणबाणा:, शशिगुणा, रसक्षितय: ।
एकोनषष्टिर्, अङ्का:; द्विद्व्येकद्व्येकवर्जिता युग्मे[6] ॥ ८ ॥

[सूर्यचन्द्रभुवां व्यासा:]

दिग्युगवेदा, बाणैकवह्नय:, खेषुपंक्तयो व्यासा: ।
रविचन्द्रमेदिनीनामुद्दिष्टा योजनात्मका: सद्भि: ॥ ९ ॥

1. C om. शैला: by haplography.
2. D, E द्व्यग, corrupt.
3. E रस for यम, wrong.
4. D, E ताराङ्कार्करसरविप्रभाकरा
5. D, E भौमान्मृदु, wrong.
6. C In the microfilm used, one page was missing, which contains the portion from ग्मे to भुवि प्र in II. 4d.

(The motions in terms of signs etc.)

10. The (number of) revolutions (given above) multiplied by 12 give the *rāśis* (signs), these multiplied by 30 give the degrees, and these (again) multiplied by 60 give the minutes. Seconds and further (denominations) are obtained by these in a similar manner (*i.e.*, by multiplying further by 60 each).

(The Orbits etc. of the planets)

11a. The orbit of a planet (in yojanas) is (given by) the number of minutes of arc of the Moon (got in verse 10) multiplied by 10 and divided by the number of revolutions of the planet (given above in verses 2-5a).

11b. The yojana measure of the epicycles (given in vv 7b-8) are in units of the 80th part of that (*i.e.*, of the moon's orbit).[1] The declination is a fifteenth part.[2]

Thus is the First Section in the

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1. This means that the parts mentioned in vv. 7b-8 are in units of 4½ degrees.

2. This is equal to saying that the obliquity of the ecliptic is 24 degrees.

[राश्यादिमानम्]

भगणा द्वादशगुणिता भानि, त्रिंशद्गुणितानि तान्यंशाः ।
ते षष्टिगुणाः कलिका; विलिप्तिकाद्यास्ततस्तद्वत् ॥ १० ॥

[ग्रहकक्ष्याः]

शशिलिप्ता दशगुणिता स्वभगणभक्ता ग्रहस्य कक्ष्या स्यात् ।
तदशीत्यंशैरुक्तं वृत्तं, तिथ्यंशसम्मिता[1] क्रान्तिः ॥ ११ ॥

[2]इति [गार्ग्य-केरल-नीलकण्ठ-विरचिते]

गोलसारे प्रथमः परिच्छेदः ॥

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1. A. B संयुता
2. D. E do not have this colophon here. In them, the First Pariccheda includes also nine verses of the next Pariccheda, after which this colophon is given.

SECTION TWO

(Situation of the Cetestial sphere)

1. The earth, a regular sphere, composed of mud etc. and sustaining itself by its own power and situated at the middle of the celestial globe supports all things around it.

2. Since all weighty things fall on the earth from the sky all around, the Earth is 'down' from everywhere and any direction opposite to it (*i.e.*, pointing away from the Earth) is 'up'.

3. The atmosphere extends some yojanas into the sky, all round the earth. Above that, the wind known as *Pravaha* blows, causing the celestial bodies to revolve.

4. That region upon the earth where *all* the stars revolving in that (*Pravaha*) region can be seen rising one after another, and where the Pole stars are (exactly) on the two sides, is called the region of Zero latitude (*i.e.*, the Equitorial region).

5. The revolving vertical circle there (*i.e.*, the Prime Vertical at that region) is called the *Ghaṭikā-maṇḍala*[1] (Hour Circle). On both sides of that are the different fixed Diurnal Circles of the heavenly bodies.[2]

6. The stellar sphere is constantly revolving westwards with the two Celestial Poles as the apices and is rotated by the *Pravaha* wind (completely once) in (a period containing) *Prāṇa-s* equal in number to the minutes of arc in a circle, (*viz.*, 21,600), (*i.e.*, in one sidereal day).[3]

7. This celestial globe is divided into twelve *rāśis*; the central great circle, (called *Apakrama-vṛtta* or the Ecliptic), is inclined to the Celestial Equator[4] so that one half of it lies to the north of it and the other to the south.

---

1. It is so called because time, in units like the *ghaṭikā*, are measured on it. The term *Viṣuvan-maṇḍala* (Equinoctial) is also applied to this great circle.

2. These are known by the name *dyu-vṛtta* or *ahorātra-vṛtta*.

3. A sidereal day is equal to 60 *nāḍikās*, a *nāḍikā* equal to 60 *vināḍikās* and a *vināḍikā* equal to 6 *prāṇas*; hence, one day is equal to $60 \times 60 \times 6 = 21,600$ *prāṇas*.

4. This obliquity is equal to 24°. See above Sn. I, verse 11d.

द्वितीयः परिच्छेदः

[गोलपरिस्थितिः]

[1]समघनवृत्ता भूमिः स्वयैव शक्त्या धृता मृदादिमयी।
ज्योतिर्गोलकमध्ये बिभर्ति विश्वं समन्ततो वस्तु ॥ १ ॥

द्रव्याणि गुरूणि यतः पतन्ति भूमौ समन्ततो नभसः।
अध एव सर्वतो भूस्, तस्मात् प्रतियोगिनी विगूर्ध्वाख्या ॥ २ ॥

कतिपययोजनपरिमितम् अतस्समन्ताद्विहायसि विहायः।
भ्रमति ह्यूर्ध्वं वायुः प्रवहाख्यो भ्रामयन् विहगान् ॥ ३ ॥

तत्र भ्रमन्ति यत्र क्रमेण दृश्यानि भानि सर्वाणि।
पार्श्वस्थे [2]ध्रुवतारे निरक्षसंज्ञो भुवि प्रदेशः सः ॥ ४ ॥

घटिकामण्डलमाहुस्तत्र यदधऊर्ध्वगं भ्रमद् वृत्तम्।
अभितोऽपि च तद् भ्रमतां भवन्ति नाना ध्रुवा द्युवृत्तानि ॥ ५ ॥

प्रत्यक् भ्रमति भचक्रं मेधीकृत्य ध्रुवौ[3] नियतम्।
चक्रकलासमसंख्यैः प्रवहेण भ्राम्यते च तत्प्राणैः ॥ ६ ॥

द्वादशराशिविभक्तो भगोल इह, तस्य मध्यवलयं[4] यत्।
अपयातं घटिकाख्यात्[5] तदर्धशस् सौम्ययाम्यदिशोः[6] ॥ ७ ॥

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1. F and G omit the preceding portion; in them the work commences only from here.
2. G om. ध्रु; gap indicated.
3. G ध्रुवे, corrupt.
4. A.B मध्यमवलयं; *i.e.*, म extra.
5. G om. त्, wrong.
6. A.B दृशोः, wrong.

8. This (circle, *viz.*, the Ecliptic) is divided into *rāśis* (segments of 30°), *bhāgas* (degrees) and *kalās* (minutes) by circles perpendicular to it, so that, a body, wherever it may be seen (on the Celestial sphere) lies in one of the *rāśis*, *Meṣa* etc.[5]

9. The reckoning of *Lagna* (Rising point of the Ecliptic) is in relation to the central circle of the revolving celestial sphere, (*viz.*, the Ecliptic). Hence, at the moment of the rising of the *Lagna* in a particular *rāśi*, a star in a different *rāśi* may also be rising.[6]

10. The planets move in their orbits with centres at the Higher Apses of their Epicycles of the Equation of the centre. For the Sun and the Moon, the centre of the celestial sphere is the centre of the above epicycles.

11. For the other (planets), the centres (of their *Manda* circles) are on (the circumference of) their *Śīghra* circles concentric with the Ecliptic. One half of their *Manda* circles is deflected northwards from the Ascending Node and the subsequent half southwards.

12. The Moon and other (planets) have their respective orbits increasing according to (the changes in their *Manda* (circles).[7] And for all (planets), the increase and decrease of the circumference of the *Manda* circles depend upon their hypotenuse.[8]

---

5. The Ecliptic is divided into 12 *rāśis* called *Meṣa* etc., commencing from a point situated near the junction-star called Zeta Piscium in the asterism of Revatī.

6. This may happen in the case of stars which are removed from the Ecliptic.

7. That is, the hypotenuse got in the *Manda*-operation is the radius of the orbit on which the planet in measured after this operation. This is a peculiarity of the school of Āryabhaṭa.

8. This is another peculiarity of the Āryabhaṭan school. The mutual dependence is resolved by resorting to what is called *aviśeṣakriyā* or successive approximation.

तत्समतिर्यग्वलयैः प्रविभज्यन्तेऽत्र राशिभागकलाः ।
यत्र क्वापि च दृष्टं ज्योतिर्मेषादिराशिगं तस्मात्[1] ॥ ८ ॥

लग्नव्यवहारस्तु भ्रमद्[2]भगोलस्थमध्यवृत्तवशात् ।
स्वाधिष्ठितात्तथोद्यति भिन्ने राशावुड्डूदयोऽपि[3] भवेत्[4] ॥ ९ ॥

निजमन्दपरिधिगोच्चं केन्द्रीकृत्य[5] भ्रमन्ति कक्ष्यासु ।
विहगा; रविचन्द्रमसो[6]र्भगोलमध्यं स्वमन्दवृतिमध्यम्[7] ॥ १० ॥

अपमण्डलमध्यस्थ[8]स्वशीघ्रवृतिसंगतोच्चमन्येषाम् ।
पाताद्[9] विक्षिप्तमुदङ्मृदुवृत्तार्धं, ततोऽन्यतोऽन्यार्धम्[10] ॥ ११ ॥

चन्द्रादीनां मन्दानुसारतः स्वस्वकक्ष्याः स्युः ।
क्षयवृद्धी सर्वेषां परिधेर्मान्दस्य तु स्वकर्णवशात् ॥ १२ ॥

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1. C. F. G राशिगस्तस्मात्
2. C भ्रमन्
3. G gap for वुड्डू ; हि for पि
4. D. E. F. G indicate the end of Pariccheda I, here, with the colophon, इति गार्ग्यकेरल-नीलकण्ठ-विरचिते गोलसारे प्रथमः परिच्छेदः (D. E add यज्व after नीलकण्ठ).
5. D मेधीकृत्य
6. E मसौ
7. D, E केन्द्रम् for मध्यम्
8. A. B. C, मध्यस्य, corrupt.
9. A. B. C पादात्, wrong.
10. After उदङ्, some mss. are corrupt : A.B.C. वृत्ताद्यार्धमन्यतोन्यार्धम् ; F.G. वृत्तार्धं ततोमन्यतोन्यार्धम् ।

13. Of the planets which move, each in its own orbit, eastwards (in relation to the stars fixed on the celestial globe which, as a whole, is moving westwards), the motion in yojanas is equal. But their (angular) motion in minutes is different, (for the same planet at different positions) as also from one another's (owing to variance in the hypotenuse and the magnitude of the orbits, respectively).

14. To fix the mid-day for these (planets) which move (apparently) westwards, a fixed north-south lying great circle *situated* equally on both sides of (mid-) day and night is presumed.

15. This (circle) is the horizon at the equator, and is called *Unmaṇḍala* elsewhere. In regions other than the equator, the *Samamaṇḍala* (which coincides with the Hour Circle at the equator), too, varies from place to place, (*i.e.*, in different terrestrial longitudes).

Thus is the Second Section in the

QUINTESSENCE OF SPHERICAL ASTRONOMY

by Gārgya-Kerala Nilakaṇṭha

प्राचां(?प्राचीं)[1] भ्रमतां स्वे स्वे कक्ष्यावलये[2] तु योजनैस्तुल्या ।
लिप्ताभोगाद्[3] भिन्ना गतिर्ग्रहाणां मिथो वापि ॥ १३ ॥

प्रत्यग् भ्रमतां तेषां दिनार्धक्लृप्त्यै[4] प्रकल्प्यते स्थायि ।
वलयमुदग्दक्षिणतः समपार्श्वस्थं [5]च दिवसनिशोः ॥ १४ ॥

एतन्निरक्षदेशजम् उन्मण्डलमवनिजं (?अवनिजमुन्मण्डलं)[6] ततोऽन्यत्र ।
सममण्डलमपि भिन्नं घटिकावृत्तात् स्वदेशवशात् ॥ १५ ॥

इति गार्ग्य-केरल-नीलकण्ठविरचिते[7]
गोलसारे द्वितीयः परिच्छेदः ॥

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1. All mss. read प्राचां ; the word ought to be प्राचीं ।
2. D कक्ष्यावृत्ते
3. A. B. C कक्ष्याभेदाद् ; D कक्ष्याभेदैः ; E लिप्ताभेदाद् ।
4. G om. क्लृ; gap indicated. 5. G om. च दिव; gap indicated.
6. All mss. read उन्मण्डलमवनिजम् ; the interchange of the words would make the meaning straight and clear.
7. A. B. C त- for ते ; E reads the entire colophon as इति द्वितीयः परिच्छेदः ।

Section Three

(Introductory)

1. By the motion of one of the planets, whose motions are thus related, the motion of another is possible to be computed, and, thus, all the motions, by the inter-relationship[1] of the motions.

2. In order to get, on the stellar sphere, the motion of the planets which are moving in their own separate orbits, the R Sine, the R Versine etc.[2] are required to be known. Therefore, I shall give, hereunder, the method of knowing them.

(The Pythagoras)

3-4a. Making a square equal to the base (of a right-angled triangle) and another equal to the perpendicular, coincide, so that two right angles come together, and marking points on the base at a distance equal to base-minus-perpendicular, draw, from the corners, lines equal to the hypotenuse that is to be found.

4b. Determining the triangles formed by the lines, draw them off and attach them (to the sides).

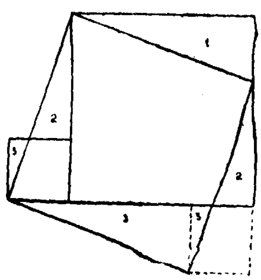
5. Then, the square formed by the equal hypotenuses is seen equal to the square on the hypotenuse (of the right angled triangle). Therefore, it is proper to say that the sum of the squares on the base and perpendicular is equal to the square on the hypotenuse.[3]

---

1. The relationship is given in I. ii.

2. If the arc of a circle is taken as bow (*cāpa*), the chord is the bow-string (*jyā*). But it is customary to take the half-chord as the R sine of the half-arc. The arrow is the R versine.

3. The fig. illustrates 3-5. The strips 1, 2, 3, cut off from the side-squares exactly fits the strips 1, 2, 3, in the hypotenuse-square.



तत्समतिर्यग्वलयैः प्रविभज्यन्तेऽत्र राशिभागकलाः ।
यत्र क्वापि च दृष्टं ज्योतिर्मेषादिराशिगं तस्मात्[1] ॥ ८ ॥

लग्नव्यवहारस्तु भ्रमद्[2]भगोलस्थमध्यवृत्तवशात् ।
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विहगाः रविचन्द्रमसो[6]र्भगोलमध्यं स्वमन्दवृतिमध्यम्[7] ॥ १० ॥

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पाताद्[9] विक्षिप्तमुदङ्मृदुवृत्तार्धं, ततोऽन्यतोऽन्यार्धम्[10] ॥ ११ ॥

चन्द्रादीनां मन्दानुसारतः स्वस्वकक्ष्याः स्युः ।
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1. C. F. G राशिगस्तस्मात् 2. C भ्रमन्
3. G gap for डुडू ; हि for पि
4. D. E. F. G indicate the end of Pariccheda I, here, with the colophon, इति गार्ग्यकेरल-नीलकण्ठ-विरचिते गोलसारे प्रथमः परिच्छेदः (D. E add यज्व after नीलकण्ठ).
5. D मेथीकृत्य 6. E मसौ
7. D. E केन्द्रम् for मध्यम् 8. A. B. C. मध्यस्य, corrupt.
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Thus is the Second Section in the

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3. A. B. C कक्ष्याभेदाद् ; D कक्ष्याभेदैः ; E लिप्ताभेदाद् ।
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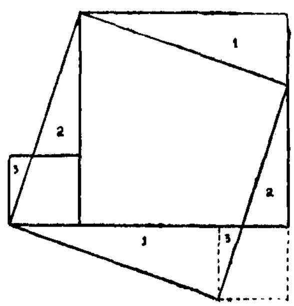
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3. The fig. illustrates 3-5. The strips 1, 2, 3, cut off from the side-squares exactly fits the strips 1, 2, 3, in the hypotenuse-square.



तृतीयः परिच्छेदः

[उपोद्घातः]

एवं नियतगतीनां गत्या कस्यचिविहान्यगतिमानम् ।
अनुमीयते च,[1] गतयो,[2] ज्योतिर्भुक्तेः परस्परं नियमात् ॥ १ ॥

यत्र क्वापि भ्रमतां नभश्चराणां भगोलगतिसिद्धयै ।
ज्याबाणादि ज्ञेयं; तस्मात्तदुपायमिह वक्ष्ये ॥ २ ॥

[भुजकोटिकर्णसम्बन्धः]

दोःसमचतुरश्रं यत्, कोटीतुल्यं[3] च, ते उभे श्लिष्टे ।
कृत्वा, [4]तत्कोणयुतेर्दोःकोटयन्तरसमान्महत्यनयोः ॥ ३ ॥

कुर्यात् प्रतिकोणान्तं जिज्ञासितकर्णसम्मिते रेखे ।
रेखायेगात् त्र्यश्रे निष्कृष्य भ्रामयन् च संवध्यात् ॥ ४ ॥

समकर्णं[5] चतुरश्रं जिज्ञासितकर्णबाहु भवति तदा ।
दोःकोटिवर्गयोगो वर्गः कर्णस्य युज्यते तस्मात् ॥ ५ ॥

---

1. D. E. F. G व for च
2. D. E. F. G गतया for गतियो
3. C तुलं
4. E दोःकोण, wrong.
5. E समकर्णः, wrong.

(The R Sines etc. graphically)

6. In a circle, making the radius the base (of a triagle) and the other two sides equal to it, and dropping a perpendicular from the intersection of the two sides, (*viz.*, the vertex), the two segments of the base (thus formed) are each equal to half the side, (*i.e.*, the radius).

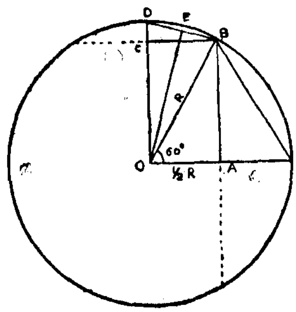
7. The segment itself is (thus seen to be) the R Sine of the remaining arc of the quadrant. Therefore, R Sine one *rāśi*, *i.e.*, 30°, is half the radius.

8-9a. The R Cosine related to it is the perpendicular, (which is thus the R Sine of 60°). The hypotenuse of (the triangle having for its sides) the two half-chords, is the radius. The radius-minus-R Cosine is the arrow, (*i.e.*, R Versine), referring to the R Sine. Then, from the hypotenuse of these two, (*viz.*, the R Sine and R Versine), R Sines (15°, 7½°) etc. should be found by the repeated working in the circle.[1]

(The approximate arc and the circumference)

9b. The length of the arc is approximately the square-root of the sum of the square of the R Sine and four-thirds the square of the R Versine.[2]

10. Thus, the arc forming some definite fraction of the circumference should be chosen as the arc (for intervals of which the tabular R Sines are given). Of these arcs, (two sets of) R Sine differences are inter-related by the two R Sines at the middle of the sets, and the next difference also, situated on the same side, in the same manner, by ths R Sine at the junction of the (related) two arcs.[3]



1. See fig.
$OA = BC = R \sin 30°$
$AB = OC = R \sin 60° = R \cos 30°$
$CD = R$ versine 30°.
$DB^2 = CD^2 + BC^2$
$DB/2 = DE = R \sin 15°$. And so on.

2. *I.e*, arc $= \sqrt{4/3(R\ \text{Versine})^2 + (R\ \text{Sine})^2}$.
If $R\theta$ is the arc, where θ is in radians, we have the formula correct to θ^5. This formula has a two-fold purpose. A small arc can be taken as its R Sine itself. The sum of the small arcs is the circumference.

3. This means, that the R Sine and its adjacent R Sine differences are inter-related, so that each R Sine can be computed successively by working as instructed in verses 13-14, following.

[भुजज्यादिकम्]

समवृत्ते व्यासार्धं कृत्वा भूमिं, भुजे च[1] तत्तुल्ये ।
लम्बं च भुजायोगाद्, बाह्वर्धसमे तदाबाधे ॥ ६ ॥

आबाधैवा[2]र्धज्या परिधेः पादेऽत्र[3] शिष्टचापभवा ।
राशेरर्धज्या सा व्यासार्धदलेन सम्मिता तस्मात् ॥ ७ ॥

तस्याः कोटिर्लम्बः, कर्णो व्यासार्धमर्धमौर्विकयोः ।
कोटयूनं व्यासार्धं बाह्वोर्बाणस् , ततस्तयोः कर्णात् ॥ ८ ॥

अर्धज्याविक्रमेवं युक्त्या नेयं मुहुर्मुहुर्वृत्ते ।

[आसन्नमानचापस्य परिधिः]

सत्र्यंशाविषुवर्गात् ज्यावर्गाढ्यात् पदं धनुः प्रायः ॥ ९ ॥

एवं परिधेरंशो प्राग्यः कथंचिदेव[4] चापतया ।
तेषु तु खण्डज्ये तन्मध्यज्याभ्यां परस्परं नियते ॥ १० ॥

खण्डान्तरमपि चापद्वयसन्ध्यग्रज्यया समानदिशा ।

---

1. E तु for च
2. E र्वा, wrong.
3. E पारेऽत्र, wrong.
4. E, G कथितश्चिदेव

11b. The circumferences are also taken as divided into minutes in a circle.

12a. If the diameter is 113 units in length, the circumference (very closely) approximates to 355 units in length.[1]

12b-13a. Whatever thing, by whatever means, in whatever manner is known to be of whatever form, that, by that means, and in that manner, indicates a similar thing of the same form.[2]

(The tabular R Sines by computation)

13b-14a. To get the R Sines successively previous to the one already found, multiply this R Sine by twice the very last difference, and divide by the radius. The result plus the difference (using which this R Sine has been found) is the difference to be subtracted from this R Sine to get the next previous R Sine.[3]

14b. The R Sine of any desired arc in excess or defect (of a given arc for which the tabular R Sine is given) can be found by using the hypotenuse, the base, the perpendicular etc., (in the manner mentioned already).[4]

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1. *I.e.*, π is very nearly equal to 355/113.

2. This refers to the similarity of figures and operations.

3. The very last difference is supposed to be known, this being the difference between the radius and the penultimate R Sine, which itself is the R Cosine of the first R Sine, which is again taken equal to the corresponding arc. For example, if there are 24 R Sines in the quadrant, and if minutes of arc are taken as units, the radius is 3438 and is the 24th R Sine. The 23rd is $\sqrt{3438^2-225^2}=3430.6$, and the last difference is 7.4. Twice this is 14.8. The difference between the 23rd and the 22nd is $3431 \times 14.8 \div 3438+7.4=22$. Subtracting 22 from 3431, the 22nd is 3409. The difference between the 22nd and 21st is $3409 \times 14.8 \div 3438+22=37$. The 21st is $3409-37=3372$. The difference between 21st and 20th is $3372 \times 14.8 \div 3438+37=51$. The 20th is $3372-51=3321$. And so on.

4. This is for securing accuracy. Otherwise, interpolation by the differences would suffice. The formula is: $R \sin(\theta \pm \alpha) = R \sin \quad . \cos\alpha \pm R \cos\theta . \sin\alpha = R \sin\theta \left(1-\frac{\alpha^2}{2}\right) \pm \alpha R \cos\theta$, where α is in radians, and sufficiently small. It is this formula that is the basis for the instruction in verses 13b-14a.

चक्रकलाश्च विभक्तान्यखिलान्यपि मण्डलानि कल्प्यन्ते ॥ ११ ॥

विश्वैकसमो व्यासः परिधेः [1]प्रायोऽर्थबाणगुणभागाः ।

यद्येन यथा नियतं यथादृशं[2] यादृशेन विदितमिह ॥ १२ ॥

तत् तस्य तथा गमकं तथाविधं तादृगन्यत्र ।[3]

[ज्यानयनम्]

द्विघ्नान्त्यखण्डनिघ्नात् तत्तज्ज्यार्धात्[4] त्रिभज्याप्तम् ॥ १३ ॥

अन्त्यादिखण्डयुक्तं त्याज्यं स्यात् पूर्वपूर्वगुणसिद्ध्यै ।

न्यूनाधिकचापज्याश्रुतिदोःकोट्यादिभिस्त्व[5]भीष्टज्या ॥ १४ ॥

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1. G प्रायोऽर्थबाण has strayed down after अन्त्या, below in v. 14.

2. E. G यथाविधं

3. E. F. G तादृशोऽन्यत्र

4. A.B निघ्नात्तज्ज्यार्धात्, wrong.

5. G om. स्त्व ; gap indicated.

15. The anomaly forming the difference between the planet and its apogee, and measured by the known planet's circle, (whether mean or *Śīghra*,) is (ultimately) measured by the minutes on the orbit of the knowable (*i.e.*, true) planet. And there is difference between the two.

16. The orbit is measured by the base and perpendicular on the *Manda*-circle centered at the centre of the orbit, and measured by the circle of the hypotenuse.

17a. Or, it is also measured by the radius of the orbit got from the true base and perpendicular.

17b. It is this hypotenuse circle that is deflected (from the ecliptic), since the deflection (giving the latitude) is that of the planet on this.

18. Even there, the deflection is measured, not in yojanas, but by itself, (*i.e.*, the angle). Therefore, it is not got by the hypotenuse, since it is measured on a circle always even (*i.e.*, of unchanging radius.)

19-20. This is on the *Śīghra* circle (in the case of Mercury and Venus). When this is projected on the orbit, the resulting perpendicular circle is to be got. The hypotenuse (of the equation of conjunction) is to be got by using the two results, (*i.e.*, R Sine and R Cosine) of the orbit, formed by the segments of the motion of the planet, of circles varying according to the perpendiculars got from the deflection as base, and multiplying by the hypotenuse, and dividing by the radius. The R Sine (of the equation of conjunction) multiplied by the radius, and divided by the above is the R Sine forming the result, (to be applied in the last operation).

विदितविहङ्गमवृत्तप्रमिता ग्रहतद्वृत्तविवरभुजा ।
वेद्यग्रहवलयोद्भवलिप्ताभिर्मीयते, भिदा च तयोः ॥ १५ ॥

कक्ष्यामण्डल[1]मध्यस्थमन्दवृत्तस्थबाहुकोटिभ्याम् ।
श्रुतिवृत्तप्रमिताभ्यां तन्मानेनात्र मीयते कक्ष्या ॥ १६ ॥

स्फुटभुजकोटिभ्यां वा परिधिव्यासार्धतोऽपि तन्मानम् ।
श्रुतिवृत्तमिदं क्षिप्तं ह्यत्रत्यग्रहवशाद्यतः क्षेपः ॥ १७ ॥

तत्रापि स्वप्रमितः क्षेपो, न तु[2] योजनैः समानतया ।
तेन न कर्णो[3]नाप्यः, प्रमितः स हि कक्ष्यया सदा समया ॥ १८ ॥

[4]एतत्कक्ष्या शीघ्रे[5] क्षिप्तेऽस्मिन् कोटिमण्डलं च ततः ।
कर्णघ्नत्रिज्याप्तक्षेपभुजामान्द[6]कर्णकोटिकया ॥ १९ ॥

विहगभ्रमवलयांशैरुदितात् परिधेः फलाभ्यां च ।
साध्यः कर्णस् , तेन त्रिज्याघ्नाद् दोःफलात्तु विवरभुजा ॥ २० ॥

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1. A. B. C. add an extra वृत्त here, wrongly.
2. A. B नतिः ; C. नति ; wrong.
3. G om. र्णो; gap indicated.
4. G om. ए
5. C कक्ष्यपर्शीघ्रे, corrupt.
6. E मन्द for मान्द

21. Getting the true planet in this manner is only for the two, (*viz.*, Mercury and Venus). For Mars, Jupiter and Saturn, the perpendicular projected from the hypotenuse forming the distance between the earth and planet, is the hypotenuse, and the base is the deflection mentioned.

22. This base, multiplied by the radius and divided the distance between the earth and planet is the true (*i.e.*, geocentric) latitude. Therefore, the latitude got on the *Manda* circle, multiplied by the *Manda*-hypotenuse is divided by this (*viz.*, the distance between the earth and the planet.)

23. Or, the hypotenuse is first to be got, using the radius of the mean planet's orbit. In getting here the perpendicular related to that, the latitude got by the *Manda*-circle is the true base.

24. Here, in the case of Venus and Mercury, their mean is corrected ley the equation of the centre. The latitude also is got from this, but this being applied to the apsis of conjuction inversely.

25. But since the orbit is smaller than the *Śīghra* circle, it, (*i.e.*, the latitude) is multiplied by the perpendicular got from the *Manda*-hypotenuse and the latitude, (taken as base), and divided by the radius, to become true.

26. The deflection listed by the wise (*i.e.*, the authoritative writers) is to be multiplied by the radius and divided by the final result. Here, the distance between the earth and the (true) planet is to be taken as the final result. Therefore, it, (*i.e.*, the latitude), becomes true by that.

27. The mean sun corrected by their (*i.e.*, of Mercury and Venus) equation of conjunction, is their true position. Their yojana measures are to be multiplied by their true distances and their *Manda*-hypotenuse and divided by their distances above.

एवमिह स्फुटसिद्धिर्द्वाभ्यामेवारमन्दजीवानाम् ।
[1]भूग्रहविवरश्रवणे कोटिः कर्णो भुजोक्त[2]विक्षेपः ॥ २१ ॥

सैव भुजा त्रिज्याघ्ना भूग्रहविवरोद्धृता स्फुटः क्षेपः[3] ।
मान्दश्रुतिनिघ्नोऽतो[4] मान्दः क्षेपो[5] विभज्यतेऽनेन ॥ २२ ॥

विदितग्रहवलयमितात् परिधेर्व्यासार्धतोऽथवा कर्णः ।
तस्य च कोटित्वेऽत्र[6] क्षेपो मान्दो भुजा ततः स्पष्टा[7] ॥ २३ ॥

प्राग्वन्मान्द[8]फलेन स्वमध्यमं स्पष्टमत्र बुधसितयोः ।
[9]तत एव च विक्षेपः पुनः स्वशीघ्रोच्चयोर्विपर्यासः[10] ॥ २४ ॥

अल्पतया कक्ष्यायाः शैघ्राद् वृत्तात्तदाहृत्य ।
मन्दश्रुतिविक्षिप्त्योः[11] कोट्या[12] त्रिज्याहृतं स्फुटं तदिह ॥ २५ ॥

क्षेपो हि बुधैः पठितस्त्रिज्यानिघ्नोऽन्त्यफलभाज्यः ।
भूग्रहविवरार्धमिहाप्यन्त्यो ग्राह्यः स्फुटश्च[13] ततः ॥ २६ ॥

शीघ्रफलेनैव रवेः संस्कृतमिह मध्यमं स्फुटं[14] तु तयोः ।
स्वक्षितिविवरघ्नं तद्योजनमपि केवलान्त्य[15]फलभाज्यम् ॥ २७ ॥

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1. E alone has this reading. The reading in the other mss., being दोर्ग्रह, seems to be corrupt.
2. A र्क for क्त
3. E स्फुटक्षेपः
4. G (अ)सौ for (अ)तो
5. E मन्दक्षेपो; G मान्दक्षेपो
6. A. B कोटिक्षेत्र-; C कोटिक्षेत्रे, corrupt.
7. G स्पष्टः
8. F. G मन्द for मान्द
9. D line broken :…एव…विक्षेपा पुनस्व…घ्रोच्चयो विपर्यासः ।
10. D. E The further portion of the work, *viz.*, verses 25-30. missing.
11. C विक्षिप्तेः
12. F. G कोटयां
13. C ग्राह्यस्फुटश्च; G स्फुटञ्च
14. G मध्यमस्फुटं
15. A. B. C केवलं तु, corrupt.

28-29a. The (motions of the) planets on the stellar sphere are thus ruled by motions caused multifariously. The motions of these are ruled by those. The inter-dependence is, thus, resolved by resorting to successive approximation.

29b. The motion caused by the *Pravaha* wind, (*i.e.*, the diurnal motion), of the stellar sphere, (*i.e.*, the sidereal day,) being uniform, all the motions can be measured by this motion as unit.

30. On the celestial sphere, the intersection, (called the First Point of Aries), of the hour-circle (*i.e.*, the Celestial Equator) and the ecliptic, oscillates east-wards and west-wards. The stellar sphere is raised up by the rising up of the moon, along the line joining the sun and Rāhu.

Thus is the Third Section in the
QUINTESSENCE OF SPHERICAL ASTRONOMY
by Gārgya-Kerala Nīlakaṇṭha

बाहुकरण(?बहुकारण)गतिकत्वादेवं[1] नियता ग्रहा भगोलगताः ।
कतमेन चिदेवैषां ज्ञेयः कालस्तु[2] तद्गति[3]कालात् ॥ २८ ॥

इत्यन्योन्याश्रयताप्यसकृत्क्रियया निराक्रियते ।
समसमयत्वात् प्रवहभ्रमणस्यानेन ते परिच्छेद्याः ॥ २९ ॥

घटिकापक्रममण्डलयोगश्चलतीह पूर्वपश्चिमयोः ।
रवितमसोः सूत्रेणोद्गच्छति चन्द्रोच्चतो भगोलोऽपि ॥ ३० ॥

इति गार्ग्य-केरल-नीलकण्ठविरचिते[4]
गोलसारे तृतीयः परिच्छेदः ॥

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1. G देव
2. A. B. C ज्ञेयकालस्य
3. G तद्गतिः
4. A.B.C विरचित-; F. G read merely तृतीयः परिच्छेदः ।

गार्ग्यकेरल-नीलकण्ठसोमयाजिकृत-
गोलसारान्तर्गत-
श्लोकार्धानुक्रमणिका

CHAPTER IX

RĀŚIGOLASPHUṬĀNĪTI ACCORDING TO ACYUTA

('TRUE LONGITUDE COMPUTATION ON THE SPHERE OF ZODIAC')

Critically edited with

Introduction, Translation and Appendix

CONTENTS

INTRODUCTION

The *Rāśigolasphuṭānīti* is a highly interesting work on Indian astronomy, which sets out the views of Acyuta Piṣāraṭi, a versatile Kerala scholar, on a very pertinent point in celestial measurements, *viz.*, whether the longitudes of planets and stars are to be measured along the ecliptic (*Apakrama* or *Krānti-vṛtta*) or each along its own path (*Vikṣepa-vṛtta*).

Manuscript material

A. Two manuscripts of this work have been identified. One, designated A, I came across by chance while examining a composite codex (No. Mal. D. 339) in the Govt. Oriental Mss. Library, Madras. catalogued under the general title of *Parahita-dṛksiddha-gaṇitam*, and copied from an original Malayalam palmleaf manuscript from Kerala. This codex contains several works, some complete and some incomplete, some in Sanskrit and some in Malayalam. The present work occurs on pages 90 to 95. There is no title nor colophon. The beginning bears the usual invocation found in Kerala manuscripts, हरि: श्री: गणपतये नम:, and at the end, the closing sign श्री:. The text preserved is generally pure ; the few lapses of the scribe can easily be corrected. Lacunae of a few letters occur in two or three places ; these have been tentatively filled in. Corrections and emendations are shown in footnotes.

B. The second manuscript, again, was the result of a chance discovery, made while examining a composite palmleaf codex in Malayalam script, deposited in the Kerala University Oriental Res. Institute and Mss. Library, Trivandrum, (No. 755), and catalogued under a general title *Gaṇitayuktayaḥ*, on the basis of the first work contained in the codex. The present work occurs as the seventh (G) in the codex and is inscribed in thirteen leaves, numbered 1 to 13. The writing is clear and generally free from errors. The manuscript is not dated, nor any scribe mentioned. It commences with the scribal benediction : हरि: श्री: गणपतये नम: । अविघ्नमस्तु ।

The textual verses in this manuscript ends with verse 51 and does not extend further. However, it contains, in continuation, an elaborate discussion on verse 51, which is edited below as Appendix I.

Acyuta, the astronomer

Acyuta is generally known in Kerala as Tṛkkaṇṭiyūr Acyuta Piṣāraṭi, Tṛ-k-kaṇṭiyūr (Kuṇḍapura in Sanskrit), near Tirur in South Malabar, being his native place, and Piṣāraṭi, the name of his caste, being the term for one of the external functionaries in a Kerala temple. Acyuta was a profound scholar in grammar and astronomy. He was a pupil of Jyeṣṭhadeva[1] and was patronised by King Ravi Varma of Veṭṭattunāḍ (Skt. Prakāśa-viṣaya),[2] a small principality situated in the present north-eastern part of the Ponnani Taluk of South Malabar. Poet Vāsudeva, in his *Bhṛṅgasandeśa,* pays high tribute to Acyuta's reputation as an astronomer,[3] while Nārāyaṇa Bhaṭṭatiri who learnt grammar from Acyuta, speaks of his teacher's proficiency not only in astronomy and grammar but also in medicine and poetics.[4]

Acyuta's greatness is enhanced by long lines of disciples. One of these starts from his pupil in grammar, Melputtūr Nārāyaṇa Bhaṭṭatiri, one of the greatest of Kerala poets and the author of *Prakriyāsarvasva* and numerous other works. Another line of disciples carried the tradition of his teachings in the subject of *jyotiṣa* to comparatively recent times. To this belonged Tṛppāṇikkara Poduvāḷ,

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1. *Cf.* the concluding verse of his *Uparāga-kriyākrama* :

प्रोक्तः प्रवयसो ध्यानाद् ज्येष्ठदेवस्य सद्गुरोः ।
विच्युताशेषदोषेणेत्यच्युतेन क्रियाक्रमः ।।

2. The reference to this King occurs in two of Acyuta's works, *viz., Sphuṭanirṇaya* and *Praveśaka.*

3. *Cf.* : तस्मात् प्रत्यक्प्रहितनयनः कुण्डगेहाधिवासं
सर्वज्ञं तं प्रणम गिरिशं भक्तिमानच्युतं च ।
एकस्तावद् वहति शिरसि ज्योतिषामेकमिन्दुं
ज्योतिश्चक्रं निखिलमपरो धारयत्यन्तरङ्गे ।।

Bhṛṅgasandeśa, Trivandrum Skt. Ser., No. 128, p. 17.

4. *Cf.* Bhaṭṭatiri's obituary verse on his teacher :
भ्रातर्ज्योतिषतन्त्र ! पर्यवसिता तिथ्यर्क्षयोस्ते कथा
धाष्ट्र्यैकप्रवणासि वैद्यसरणे ! नष्टोऽस्यलङ्कार भोः ।
हे शब्दागम ! निर्दयं विबुधतालुब्धैर्निपीडिष्यसे
'विद्यात्मा स्वरसर्प'दत्रभवतामाधारभूरच्युतः ।।

Nāvāyikkuḷattu Āzhāti, Pulimukhattu Poṭṭi and Neḍumpayil Kṛṣṇan Āśān, each prominent during his own time.[5] It can aptly be said of Acyuta, शिष्यप्रख्यातिर्यशसे गुरूणाम् 'The fame of the pupils accrues to the glory of the teacher'.

Date of Acyuta

The date of birth of Acyuta should be *circa* 1550 since his famous pupil Melputtūr Nārāyaṇa Bhaṭṭatiri was born in 1560, (*vide* S. Venkitasubramonia Iyer, *Nārāyaṇa Bhaṭṭa's Prakriyāsarvasva*, Trivandrum, 1972, pp. 22-23). The date of Acyuta's death is given by the Kali date विद्यात्मा स्वरसपंत् (17,24,514, which works out to be A.D. 1621) in his obituary verse भ्रातर्ज्योतिषतन्त्र etc. composed by Nārāyaṇa Bhaṭṭatiri.

Known works of Acyuta

Praveśaka, an illustrative treatise on grammar intended for beginners, is the only known work of Acyuta on this subject.[6] Acyuta's works on astronomy are : *Sphuṭanirṇaya-Tantra* with auto-commentary, an erudite work in six chapters on the correct computation of the planets,[7] *Chāyāṣṭaka*, on the determination of the gnomonic shadow cast by the Moon ; [8] *Karaṇottama*, a manual in five chapters with auto-commentary ; [9] *Uparāga-kriyākrama*, in four chapters, on the computation of lunar and solar eclipses ; *Horāsāroccaya*, which is an adaptation in seven chapters of Śrīpati's *Jātakapaddhati* ; and a Malayalam commentary on the *Veṇvāroha* of Mādhava of Saṅgamagrāma,

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5. On these see K. V. Sarma, 'Direct lines of astronomical tradition in Kerala', *Charudeva Shastri Felicitation Volume*, Delhi, 1973, pp. 601-4.

6. Ed. with the commentary of P. S. Anantanaryana Sastri, *Cochin Sanskrit Series*, No. 2, Trippunithura, 1938.

7. Cr. ed. with Intro. and 10 Appendices, by K. V. Sarma, Hoshiarpur, 1974.

8. Cr. ed. by K.V. Sarma, as Appendix 10 to the edition of *Sphuṭanirṇaya*.

9. Ed. by K. Raghavan Pillai, *Trivandrum Skt. Ser.*, No. 213, 1964.

an early reputed Kerala astronomer generally styled as *Golavid* by later writers. Acyuta wrote this last commentary at the instance of Netranārāyaṇa (in Malayalam : Āzhvāñceri Tamprākkaḷ), the spiritual head of the Nampūtiri Brahmans.[10]

Rāśigolasphuṭānīti

As observed before, the *Rāśigolasphuṭānīti* concerns itself with a detailed discussion on the measurement of the longitudes of celestial bodies in the 'Sphere of Zodiac', the *Rāśigola*. What is meant by *Rāśigola* may be briefly stated here.

The Rāśigola

Indian astronomers envisage the celestial globe from three points of view. In the first case it is called the 'Sphere of Space' (*Khagola*). Here the position of the observer is the centre, the horizon around him is the horizontal great circle, and the *Sama-maṇḍala* (Prime vertical) and *Dakṣiṇottara-vṛtta* (Celestial meridian) are the other two great circles. Obviously, the *Khagola* differs from place to place and from moment to moment, with the result that the Alt-Azimuth co-ordinates of a star which is measured on the fundamental circles of this sphere are also constantly changing. The second conception is that of the 'Atmospheric sphere' (*Vāyugola*) based on the path of the apparent motion of the stars. The basic great circles in this case are : the *Ghaṭikā-vṛtta* or *Viṣuvan-maṇḍala* (Celestial Equator) which is the apparent path of a star which rises exactly in the East ; the *Unmaṇḍala* or *Laṅkā-kṣitija*, the great circle passing through the Celestial Poles at 90° to the Celestial Equator ; and the *Dakṣiṇottara-vṛtta* 90° from the Equinoxes, called the Solstitial Colure. The position of a star with reference to the *Vāyugola* with right ascension-declination co-ordinates changes in course of time due to the *ayana-calana* (the precession of the equinoxes). These two systems are not therefore used in Indian astronomy to denote the positions of celestial bodies.

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10. *Cf.* the concluding verse of the commentary :

माधवन् तान् चमच्चुव्ळ वेण्वारोहत्तिनच्युतन् ।
भाषाव्याख्यानमुण्टाक्कि नेत्रनारायणाज्ञया ॥

Cr. ed. K.V. Sarma, Sanskrit College, Trippunithura, 1956.

A third conception is the 'Sphere of Zodiac' (*Rāśigola*), with the *Apakrama* or *Krānti-maṇḍala* (Ecliptic) which is the path along which the Sun apparently moves through the *nakṣatras* (Asterisms), as the prime great circle. A particular point on the *Apakrama-maṇḍala* just to the east of *Revatī* (Zeta Piscium) called *Meṣādi* (First point of *Meṣa*) is taken as the starting point and twelve equal divisions called *Rāśis*, 30° each, are marked on the ecliptic ; great circles perpendicular to the ecliptic are drawn from these points and extended on either side along the celestial sphere to meet at two points on the North and South, each called a *Rāśi-kūṭa* or *Kadamba*. These twelve circles are called *Rāśikūṭa-vṛttas*. This conception of the celestial globe is known as *Rāśigola* or *Bhagola*. Measurements with reference to this sphere are the most constant of the three.

Now, the Sun moves exactly along the *Apakrama-maṇḍala* (ecliptic) while the other planets move along great circles called *Vikṣepa-vṛttas* or *Vimaṇḍalas*, slightly deviating from it. The path of each planet will thus cut that of the Sun at two places, the Ascending Node and the Descending Node, called in Indian parlance the *Pātas*. The *Pātas* of the Moon's path are specially termed *Rāhu* and *Ketu*. The perpendicular distance between the *Apakrama-maṇḍala* and the position of a planet in its *Vikṣepa-vṛtta*, North or South of it, is termed the *Vikṣepa* (latitude) of the planet at that position.

Reduction to the Ecliptic

The position of all planets is denoted in Indian astronomy in terms of two co-ordinates, the longitude which is measured along the *Apakrama-maṇḍala* from the said *Meṣādi*, and *Vikṣepa* (latitude) perpendicular to it. A very pertinent question arises here as to why the measurements of all planets should be made along the Sun's orbit and whether it would not be more reasonable that each planet be measured along its own orbit. This question is dealt with in the work with particular reference to the Moon at the time of an eclipse and, after a detailed refutation of the second view (*vv.* 24*b*-41), it concludes that all measurements of longitude are to be made along the ecliptic and thatt he measurements of the latitude are to be made perpendicular to the ecliptic (*v.* 42).

The work then takes up the question of a correction necessary to the orbital longitude of the Moon to reduce it to the ecliptic, in view of the fact that the Moon actually moves along its orbit but its

longitude is to be measured along the ecliptic. This correction which, in a restricted sense, may be expressed by the term *Rāśigola-sphuṭa,* is in modern astronomy known as 'Reduction to the ecliptic.'

Acyuta's Formula for the correction

Acyuta has enunciated a formula for this correction in his *Sphuṭanirṇaya,* and, in the present context, the *Rāśigolasphuṭānīti* quotes (verse 51) the passage from that work :[11]

पातोनस्य विधोस्तु कोटिभुजयोर्जीवे मिथस्ताडये-
दन्त्यक्षेपशराहतं वधममुं विक्षेपकोट्या हरेत् ।
लब्धं व्यासदलोद्धृतं हिमकरे स्वर्णं, विपाते विधौ
युग्मायुग्मपदोपगे ; विधुरयं स्पष्टो भगोले भवेत् ॥

"Multiply the tabular cosine (*koṭijyā*) and sine (*bhujājya*) of Moon-minus-Node, and the product by the tabular versine (*śara*) of the maximum latitude (*antya-kṣepa*) of the Moon. Divide this by the tabular cosine of the latitude at the particular moment and the quotient is to be divided again by the tabular radius (*vyāsa-dala*). The result (will give the correction for longitude which) is to be added to or subtracted from the Moon's longitude, as Moon-minus-Node is in an even or odd quadrant, respectively. This Moon will be the True Moon as measured on the ecliptic."

This correction can be extened to the case of all planets.

Mathematical proof for the Formula

Thus, if F is the longitudinal difference between the Node and the Planet, w the maximum *Vikṣepa,* λ the actual *Vikṣepa,* and the correction required is k,

$$\text{Bhujājyā } k = \frac{\text{Bhujājyā F} \times \text{Koṭijyā F} \times \text{Śara } w}{\text{Koṭijyā } \lambda \times \text{Trijyā}}$$

$$\textit{i.e.,}\ \text{Rsin } k = \frac{\text{Rsin F} \times \text{R cos F} \times \text{Rversine } w}{\text{Rcos } \lambda \times \text{R}},\ \text{where R} = \text{Trijyā}$$

11. *Sphuṭanirṇaya,* IV. 2, edn. *ibid.,* p. 25.

$$i.e., \text{ Sin } k = \frac{R^2 \sin F \times \cos F (1-\cos w)}{R^2 \cos \lambda}$$

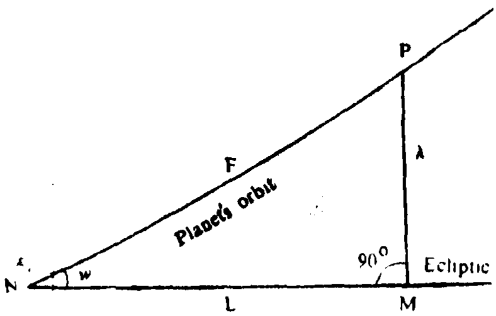
$$= \frac{\sin F. \cos F (1-\cos w)}{\cos \lambda}$$

Since k is very small, sin k might be taken to be equal to k.

$$\therefore \quad k = \frac{\sin F. \cos F (1-\cos w)}{\cos \lambda}$$

Verification of Acyuta's Formula

The exactitude of Acyuta's correction can be verified by the application of Napier's rules (A.D. 1550-1617) for a right-angled spherical triangle.



N = Node

P = Planet

F = NP = Longitudinal difference between the Node and the Planet along its orbit

L = NM = Longitudinal difference between the Node and the Planet along the ecliptic

λ = PM = Latitude of the Planet at the moment, *i.e., tatkāla-vikṣepa*

w = Angle between the ecliptic and the orbit (*parama-vikṣepa*)

From Napier's rule for △NMP,

$$\cos w = \cos F. \tan L = \frac{\cos F. \sin L}{\sin F. \cos L}$$

$$\therefore\ 1-\cos w = 1-\frac{\cos F.\sin L}{\sin F.\cos L}$$

$$=\frac{\sin F.\cos L-\cos F.\sin L}{\sin F.\cos L}$$

$$=\frac{\sin(F-L)}{\sin F.\cos L}$$

$$\therefore\ \sin(F-L)=\sin F.\cos L.(1-\cos w)$$

$$=\frac{\sin F.\cos F}{\cos\lambda}.(1-\cos w)$$

(since $\cos F=\cos\lambda.\cos L$)

If k is the correction to be applied to F to obtain L, then

$$F-L=k$$

$$\therefore\ \sin k=\frac{\sin F.\cos F}{\cos\lambda}(1-\cos w)$$

This is exactly the formula for the correction enunciated by Acyuta.

Taking the value accepted by Acyuta[12] for the maximum latitude of the Moon, *viz.*, 288′, the correction for Moon will be :

$$k=\frac{\sin F.\cos F.\ (1-\cos 288')}{\cos\lambda}$$

$$=\frac{\sin F.\cos F}{\cos\lambda}\times 0{\cdot}0035$$

Simplified formula for the Moon

The text further adds (verse 53) that Acyuta has given this correction in a simplified form in his *Kriyākrama*. *Cf.* :

अयमेव हि संस्कारो लघूकृत्य 'क्रियाक्रमे' ।
तेनैव 'क्षेपवर्गीरांशं कुर्याद्' इत्यादिनेरितः ॥

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12. *Cf.* क्षेपाः शशाङ्कात् परमाः क्रमेण नागाह्दिस्राः स्वरबाणनन्दाः ।
खवेदरामाः खकुलाचलाश्च बाणाद्रिचन्द्राः स्वरभास्कराश्च ॥

(*Sphuṭanirṇaya* I. 15)

The maximum *vikṣepa* for the Moon is नाग-अहि-दस्र, *i.e.*, 288, *kalās* or minutes.

The reference is to his *Uparāga-kriyākrama*, ch. I, verse 42 :

पर्ववत् 'क्षेपवीरांशं कुर्या' च्चन्द्रे स चन्द्रमाः ।
परमग्रासकाले स्वे स्यात् पर्वान्ते रविग्रहे ॥

where a correction of one twenty-fourth of the *Vikṣepa* at the particular moment (*tatkāla-vikṣepa*) is recommended to be applied to the Moon in the calculation of eclipses. This would give the result :

$$k = \frac{\text{Vikṣepa}}{\text{Vīra}}, \textit{ i.e. } \frac{\lambda}{24}$$

Proof for the Simplified formula

This can be derived as follows. As shown above, for the Moon

$$k = \frac{\sin F . \cos F.}{\cos \lambda} \; 0.0035$$

$= \sin F. \; 0.0035$ (since cos F and cos λ can each be taken to be 1, for at the time of an eclipse F is very near 0° or 180° and λ is still smaller.)

Now, sine latitude at any moment is equal to the sine of the maximum latitude multiplied by the sine of the longitude, *i.e.*,

$$\sin \lambda = \sin w. \; \sin F$$

$$\therefore \quad \sin F = \frac{\sin \lambda}{\sin w} = \frac{\sin \lambda}{\sin 288'} = \frac{\sin \lambda}{\cdot 0837}$$

Substituting this value in the above equation,

$$k = \frac{\sin\lambda}{\cdot 0837} \times \cdot 0035$$

$= \dfrac{\sin \lambda}{23 \cdot 91} = \dfrac{\lambda}{24}$ (Since λ is very small and taking 23.91 as 24 makes but a negligible difference.)

Identification of the correction elsewhere

The first among Western astronomers to note this correction is the German astronomer Tycho Brahe who lived between 1546 and 1601 and thus was a contemporary of Acyuta (1550-1621).

This correction of reduction to the ecliptic is not mentioned in early Indian astronomy ; and, among the mediaeval astronomers of North India, the first to mention it is Nityānanda of Indraprastha in his *Siddhāntarāja* written in 1639 A.D.[13] It redounds to the credit of Kerala astronomers to have shrewdly discerned this correction and to have derived for it a formula which tallies with modern mathematics.

Chronology of Acyuta's works

A new light on the chronology of Acyuta's works can be had from his reference to his *Sphuṭanirṇaya* and *Uparāga-krIyākrama* in the present work. The first *pāda* of the final verse of the latter work, **प्रोक्तः प्रवयसो ध्यानात्**, gives the Kali day of its completion, *viz.*, 17,14,262,[14] which works out to A.D. 1593. The *Sphuṭanirṇaya* gives the full formula for the reduction to the ecliptic (IV. 2), which the work says he has reduced to a simpler form in the *Uparāga-kriyākarma*, and, so, the *Sphuṭanirṇaya* should have been composed prior to A.D. 1593. This would mean that Acyuta had identified the reduction to the ecliptic and specified his formula for the correction earlier than A.D. 1593.

Acknowledgements

The *Rāśigolasphuṭānīti* issued now is its revised second edition. The first edition of the work had been published more than twenty years ago, in 1955, by the well-known Adyar Library and Research Centre, Madras. The book has long been out of print and the authorities of the Centre gladly permitted the publication of its second edition under the auspices of our Institute. I am deeply grateful to the Centre for the kind permission given in the above regard.

The first edition had been issued on the basis of a single manuscript of the work, thanks to the Govt. Oriental Mss. Library, Madras. The present second edition has the benefit of the use made

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13. *Cf.* Sudhakara Dvivedi, *Gaṇakataraṅgiṇī*, rev. edn., Benares, 1933, p. 101.

14. An old Malayalam commentary on this work (Mss. Trav. Uni. C. 173 E) states : *ī ślokattinte naṭe pādam grantham camaccua tīrnna Kalikkoṭṭa nāḷ ākayum uṇṭu*" ('The first *pāda* of this verse represents also the Kali date of the completion of this work').

in it of another manuscript discovered recently from the Kerala University Oriental Research Institute and Mss. Library, Trivandrum. Also, this second manuscript was of special importance since it contained a disquisition on the Reduction to the ecliptic, which is included in the present edition as Appendix I. I am extremely thankful to Dr. K. Raghavan Pillai, Director of the Institute, for making available to me the said manuscript for use in this edition.

I take this occasion to remember again with thanks, the advice rendered and suggestions given, at the time of the preparation of the first edition of the work, by Prof. T.S. Kuppanna Sastri, formerly of the Presidency College, Madras, and the late Shri Rama Varma Maru Thampurān of the scholarly royal house of Cochin.

My thanks are due in full measure also to the V.V.R.I. Press, Hoshiarpur, for the efficient printing and attractive get-up of this publication.

K. V. SARMA

Hoshiarpur,
1. 1. 1977

राशिगोलस्फुटानीतिः

[ग्रहणबीजम्]

[1]इन्दुमार्गतिरश्चीनं द्विस्पृक्सूत्रं भवेद् यदा ।
तदैव परमासत्तिर्ग्रहणे सोमसूर्ययोः ॥ १ ॥

मध्यकाले तु न तथा द्विस्पृक्सूत्रस्य संस्थितिः ।
परमग्रासकालोऽतो भिद्यते मध्यकालतः ॥ २ ॥

TRUE LONGITUDE COMPUTATION ON THE SPHERE OF ZODIAC

(Essence of an eclipse)

1. In an eclipse,[2] the maximum nearness of the Sun and the Moon occurs when the straight line joining the centres of the two (*dvi-spṛk-sūtra*) is perpendicular to the Moon's orbit.

2. At the moment of conjunction or opposition [of the Sun and the Moon] (*madhyakālu*[3] or *sphuṭa-parvānta*), the line joining the centres is not so, (*i.e.*, not perpendicular to the Moon's orbit). Consequently,

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1. Both **A** and **B** begin with the words हरिः श्रीः गणपतये नमः । **B** adds also अविघ्नमस्तु ।

2. The expression 'in an eclipse' (*grahaṇe*) presupposes that the centres of the Sun and the Moon in their respective orbits are very near the Node, so that the small arcs from the Node to the centres may be taken as straight lines. Thus, the Node, the Sun and the Moon may be taken as the vertices of a triangle. Then the least distance of a point to a straight line is the perpendicular from that point to the straight line.

3. In Indian astronomy, by *madhyakāla* is meant the *sphuṭa-parvānta* and not, as it would seem from the term, the moment of the middle of the eclipse. *Cf.*, *Sūryasiddhanta*, IV. 16 :

स्फुटतिथ्यवसाने तु मध्यग्रहणमादिशेत् ।

[पर्वान्ते पक्षद्वयम्]

अर्कमार्गतिरश्चीनां रेखां प्राप्नोति चन्द्रमाः ।
यदा, तदा स्फुटैक्यं स्याद्, इति केचन सूरयः ॥ ३ ॥

पाताद् यावतिथे भागे क्रान्तिवृत्ते रविर्भवेत् ।
विक्षेपमण्डले चन्द्रः पातात् तावतिथेऽन्तरे ॥ ४ ॥

यदा भवेत्, तदैव स्यात् पर्वान्त इति केचन ।
अर्कमार्गतिरश्चीनसूत्रात् पातानुसारतः ॥ ५ ॥

प्राग्वा पश्चाच्च भवति वर्त्मसाम्यं,[4] ततोऽपि च ।
पातासन्नप्रदेशे स्यात् सन्निकर्षः परस्तयोः ॥ ६ ॥

the moment of maximum eclipse is different from the moment of conjunction or opposition.

(Two views on Conjunction)

3. Some scholars are of opinion that the True longitudes (*sphuṭa*) [of the Sun and the Moon] are equal when the Moon reaches the perpendicular drawn from the Sun's path (*viz.*, the ecliptic) [to cut the Moon's orbit].

4-5*a*. Others, however say that moment of conjunction (*parvānta*)[5] occurs only when the Moon in its orbit (*vikṣepa-maṇḍala*) is as distant in degrees (*bhāga*) from the Node (*pāta*) as the Sun is in its orbit.

5*b*-6. This point of equality in distance (*vartma-sāmya*) on the Moon's orbit will fall either to the East or West of the perpendicular drawn to the Sun's path according as to whether the (proximate) Node is to its East or its West. The point of closest proximity lies further from the point of equality to the side where the node lies.

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4. B. कालसाम्यं ।

5. *Parvānta* really applies to both the moments of conjunction and opposition, but for the sake of facility of expression, it is translated by 'conjunction' alone (which is the case in solar eclipses), here as also below.

व्यहीन्द्वाद्योजपदगे पातः पृष्ठगतस्तयोः ।
पुरोगतो युग्मपदे ; तस्मान्मध्याख्यकालतः ॥ ७ ॥

परमग्रासकालोऽयं प्राक्पश्चाच्च भवेत् क्रमात् ।
आसत्तिकालः पर्वान्ताद् भिन्नः पक्षद्वयेऽप्यतः ॥ ८ ॥

भेदस्य तारतम्ये हि केवलं कलहो भवेत् ।
विविच्य नोक्तो भेदोऽयं यद्यप्यार्यभटादिभिः ॥ ९ ॥

तथापि युक्तिसिद्धत्वात् स्वीकृतो ह्यच्युतादिभिः ।
[पर्वान्तनिर्णयः—प्रथमः पक्षः]
मध्यकाले ह्यर्कबिम्बात् स्फुटक्षेपान्तरे विधुः ॥ १० ॥

7-8*a*. If Moon-minus-Node (*vyahīndu*) is in an odd quadrant, the Node will be behind the two, and if it be in an even quadrant the Node will be in front of them. And therefore[6] the moment of maximum eclipse will, respectively, be before or after the moment of conjunction.

8*b*-9*a*. Thus according to both views, the moment of maximum eclipse differs from the moment of conjunction. A dispute can therefore occur only in the estimation of this difference.

9*b*-10*a*. Although this distinction (between the moments of maximum eclipse and the so-called *madhyakāla* or *parvānta*) has not been expressly distinguished by Āryabhaṭa and others, it is recognized by Acyuta and others, since it is obvious by inference.

(Determination of Conjunction : First view)

10*b*-11. At the moment of conjunction, the angular distance of the Moon from the Sun is equal to its latitude corrected for parallax

6. This follows from the fact that, when nearest to the Sun, the Moon's distance from the Node must be less than the Sun's distance from the Node, the former being the hypotenuse of the right-angled triangle formed; and it is more so from the perpendicular, which is farther away on the Moon's orbit.

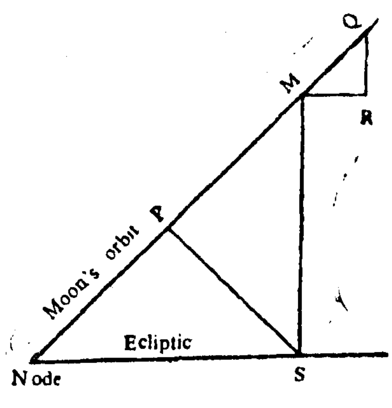
ततः प्रागथवा पश्चादर्कासत्तिर्भवेदिति ।
ज्ञातुं तत्कालसरणिर्विज्ञेया शीतदीधितेः ॥ ११ ॥

विधोस्तत्कालसरणिः कथं ज्ञेयेति चेच्छृणु ।
द्युषष्ट्यंशजभूपृष्ठस्फुटगत्यन्तरं भुजम् ॥ १२ ॥

दिनषष्ट्यंशजस्पष्टक्षेपखण्डः शराभिधः ।
तयोर्वर्गैक्यमूलं स्यात् तत्कालसरणिर्विधोः ॥ १३ ॥

(*Sphuṭa-vikṣepa*). In order to know where the point of maximum nearness to the Sun will occur, to the East or West of [the moment of conjunction], it is necessary to scan the path of the Moon at the moment.

12*a*. If you desire to know the path of the Moon at that moment, listen. [It can be described as follows] :



12*b*-13. (Let) the (*bhujā*) be one-sixtieth of the difference between the daily motions [of the Sun and the Moon] (*dyu-gatyantara*) as corrected for parallax (*bhūpṛṣṭha-sphuṭa*), (MR) ; and let one-sixtieth part of the variation in latitude (*kṣepa-khaṇḍa*) per day as corrected for parallax (*spaṣṭa*) be what is called the 'altitude'[7] (*śara*, the other

7. Though the term 'altitude' is more comprehensive, for the sake of convenience, it is used here to translate the 'altitude of a right-angled triangle' (*śara* or *koṭi*).

अर्कमार्गानुसारी स्याद् बाहुस्तद्वयस्तदिक् शरः ।
चन्द्रमार्गात्मकः कर्णः प्रमाणक्षेत्रमीदृशम् ॥ १४ ॥

मध्यक्षेपः श्रुतिर्बाहुः परमासत्तिकालजम् ।
बिम्बान्तरं, चन्द्रमार्गे तयोरग्रान्तरं शरः ॥ १५ ॥

इच्छाक्षेत्रमिदं ; तत्र ज्ञातेन श्रवणेन हि ।
अज्ञातौ दोःशरौ नेयावनुपातेन ; तद्यथा ॥ १६ ॥

[8]प्रमाणक्षेत्रकर्णस्य यद्येतौ बाहुसायकौ ।
तदेच्छाक्षेत्रकर्णस्य कौ स्तो बाहुशराविति ॥ १७ ॥

side of the right-angled triangle), (QR). Then the root of the sum of their squares (MQ) will give the Moon's path for that period (*viz.* one *nāḍikā*).

14. The base [of the right-angled triangle so formed] is parallel to the Sun's path, the altitude perpendicular to it and the hypotenuse along the orbit of the Moon. Thus is established the antecedent triangle (*pramāṇa-kṣetra*) (MRQ) [where the values of all the sides are known].

15-16*a*. The latitude at the moment of conjunction (*madhya-kṣepa*) (SM) is the hypotenuse, the line joining [the centres of] the orbs [of the Sun and the Moon] at the moment of maximum eclipse (SP), the base, and the line along the Moon's orbit joining the ends of the above two lines (PM), altitude : thus is the consequent triangle (*icchā-kṣetra*) (SPM) established.

16. Here, [in this consequent triangle], since the hypotenuse, [which is the latitude at the moment of conjunction], is known, the base and altitude can be derived by proportion [with the antecedent triangle]. This is how it is :

17. If such are the base and altitude of the antecedent triangle, what would be the base and altitude of the consequent triangle ? (By

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8. A. defective. In place of the entire verse, it reads only : प्रमाणक्षेत्रकर्णस्य कौ बाहुशराविति ।

इच्छाक्षेत्रगतौ स्यातां बाहुबाणौ ; तयोः शरः ।
गत्यन्तरात्मको ज्ञेयो यतोऽसौ चन्द्रमार्गगः ॥ १८ ॥

दिनषष्ट्यंशसम्बन्धिस्फुटगत्यन्तरात्मना ।
प्रमाणक्षेत्रकर्णेन नाडिकैका भवेद् यदि ।
तदेच्छाक्षेत्रबाणे[9] कः काल इत्यनुपाततः[10] ॥ १९ ॥

परमग्रासकालस्य भेदः स्यान्मध्यकालतः ।
द्विःकृत्वो हरणं कार्यं कर्णेनैवं यतस्ततः ॥ २० ॥

मध्यक्षेपाच्छरहतात् कर्णकृत्याप्तनाडिकाः ।

means of this argument will be derived the base and altitude of the consequent triangle :

$$\left(SP=\frac{SM.\ MR}{MQ};\ MP=\frac{SM.\ QR}{MQ}\right).$$

18. Of these two, the altitude, since it lies along the Moon's orbit, should be understood to have its value in terms of the relative motions (*gaty-antara-ātmaka*) [per *nāḍikā* projected upon the Moon's orbit].

19-20*a*. And if the hypotenuse of the antecedent triangle (MQ), which represents the relative motions [of the Sun and the Moon] for one-sixtieth of a day, is one *nāḍikā*, what time will the altitude of the consequent triangle represent ? This proportion will give the time between the moments of maximum eclipse and conjunction, *i.e.* :

$$\left(\frac{MP}{MQ}=\frac{SM.\ QR}{MQ.\ MQ}\right)$$

20*b*-21*a*. Since, [in the above calculation], division with the hypotenuse [MQ of the antecedent triangle] is to be done twice, the resultant *nāḍikās* [are] obtained by multiplying the latitude at conjunction by the altitude, and dividing the product by the square of the hypotenuse [of the antecedent triangle], *i.e.*, $\left(\frac{SM.\ QR}{MQ^2}\right)$

9. A.B. have an extra न here, बाणेन.

10. B. इत्यतियुक्तितः ।

स्वर्णं कुर्यान्मध्यकाले तयोर्दिग्भेदसाम्यतः ॥ २१ ॥
परमग्रासकालोऽयं, मध्यक्षेपाद् भुजाहतात् ।
कर्णाप्तो बिम्बभेदः स्यात् परमग्रासकालजः ॥ २२ ॥
तदूनं बिम्बयोगार्धं भवेद् ग्रासप्रमा परा[11] ।
विधोरर्कफलाप्राप्तिः पर्वान्त इति यन्मतम् ॥ २३ ॥
तन्मते प्रोक्तमखिलं युज्यते नात्र संशयः ।

21*b*-22*a*. [These *nāḍikās*] are to be added to, or subtracted from, the moment of conjunction, according as to whether the directions (North or South) of the two, (*viz*., the latitude and altitude), are different or the same, respectively.[12] This is the moment of maximum eclipse.

22. Multiply the latitude at conjunction (SM) by the base (MR) and divide by the [antecedent] hypotenuse (MQ) ; the result will be the distance between [the centres of] the orbs [of the Sun and the Moon] at the moment of maximum eclipse, *i.e.*, $\left(SP = \frac{SM \times MR}{MQ} \right)$

23*a*. This, subtracted from half the sum of the angular diameters (*bimba*) [of the Sun and the Moon], will give the maximum eclipse.

23*b*-24*a*. All that is said here accords, in fact, only with the school that says that the moment of conjunction is when the Moon

11. A. परम् ।

12. This follows from the following consideration : When the Moon at conjunction is in advance of the Node, this correction has to be deducted because the maximum-eclipse-position is behind the Moon ; under this condition the *vikṣepa* and the *śara* are both North or both South, *i.e.*, there is sameness of direction, (*dik-sāmya*). Hence the rule : '*Dik-sāmye ṛṇa*', 'Deduction when the directions are the same'. When the Moon at conjunction is behind the Node, the maximum-eclipse-point is in advance of the Moon and hence the correction has to be added. Under this condition, the *vikṣepa* and *śara* are of different directions, one North and the other South. Hence the rule '*Dig-bhede dhanam*', 'Addition when the directions are different'.

[द्वितीयपक्षखण्डनम्]

वर्त्मसाम्यं हि पर्वान्त इति पक्षे विधोर्गतिः ॥ २४ ॥

क्षेपवृत्तानुसारी स्यात् ततोऽस्या बाहुता कथम् ।
तर्हि गत्यन्तरांशस्य बाहुत्वं नेह कल्प्यते ॥ २५ ॥

किन्तु कर्णत्वमिति चेद्, भवत्वेवं शशिग्रहे ।
रविग्रहे तु कर्णत्वमपि तस्या न युज्यते ॥ २६ ॥

यतो नतिवशादिन्दोर्वर्त्म भिन्नं प्रतिक्षणम् ।
अनुगत्यन्तरांशस्य बाहुत्वं भास्वतो ग्रहे ॥ २७ ॥

बाणत्वं नतिखण्डस्य पक्षेऽस्मिन् यदि[13] कल्प्यते ।

attains the same [number of] minutes (*kalās*) as the Sun, [both measured along the ecliptic].

(Refutation of the Second view)

24*b*. But, according to the school which says that the moment of conjunction is equality of distance [from the node], [the calculations as described above are impossible for the several reasons set out below] :

25*a*. (i) [Firstly], how can this, (*viz* , the relative motion per *nāḍikā*, MR), be taken as the base in view of the fact that the motion of the Moon is [measured] along its own orbit ?

25*b*-27*a*. (ii) It may be argued that the relative motion per *nāḍikā* (*gaty-antara-aṁśa*) is not taken as the base, but only as the hypotenuse. (But it has to be noted that) this might be so in the case of the Lunar eclipse ; but, in the case of the Solar eclipse, it cannot be taken as the hypotenuse, since the path of the Moon is changing every moment owing to parallax in latitude (*nati*).

27*b*-28. (iii) If, according to this school and with reference to the Solar eclipse, it is argued : Let the relative motion [along the

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13. A. नहि for यदि ।

तदा[14] तयोर्वर्गयोगमूलस्यात्रेन्दुमार्गता ॥ २८ ॥
इति चेन्न, यतो नात्र तयोर्दोःकोटिरूपता ।
तथा हि नतिखण्डः स्याद्यस्तदिक्कोऽर्कमार्गतः ॥ २९ ॥
गत्यन्तरांशकश्चास्मिन् पक्षे स्यादिन्दुमार्गतः[15] ।
अतोऽनयोर्मिथो न स्याद्दोःकोटित्वमिति स्थितम् ॥ ३० ॥
किञ्च लम्बनखण्डेन घटिकाकालजेन च ।
ऊनितो गतिभेदांशो बाहुर्ज्ञेयः पुरोदितः ॥ ३१ ॥
तत्र लम्बनखण्डोऽयं रविमार्गगतो भवेत् ।
गत्यन्तरांशकश्चात्र चन्द्रमार्गगतो यतः ॥ ३२ ॥
ततोऽनयोर्वियोगोऽपि वस्तुतस्तु न युज्यते ।

Moon's path] (*anu-gaty-antara-aṁśa*) be taken as the base, and the variation in latitude corrected for parallax (*natl-khaṇḍa*) as the altitude, then the root of the sum of their squares will give the path of the Moon.

29-30. [The answer is :] No, because in this case they do not form the base and altitude [of a right-angled triangle] ; for, the latitudinal variation is perpendicular to the Sun's path and the longitudinal variation is [measured], according to this school, along the Moon's path and hence there cannot be any base-altitude relationship between them.

31. (iv) Further, [if it is said that] the base taken above is the relative variation in longitude (*gati-bheda-aṁśa*) minus the variation in parallax in longitude (*lambana-khaṇḍa*) per *nāḍikā* (*ghaṭikā-kālaja*) ;

32-33*a*. [this is improper]; for, here, the variation in parallax in longitude is measured along the Sun's path ; but the relative variation in longitude is (measured) along the Moon's path ; (these two are different) ; hence the subtraction of one from the other is, in fact, not possible.

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14. A. तथा for तदा.
15. B. मार्गग:

एतद्दोषनिरासार्थं यद्यत्र नतिलम्बने ॥ ३३ ॥

तयोः खण्डौ च नीयन्ते भास्करोक्तेन मार्गतः[16] ।

तर्हि लम्बनखण्डस्य गत्यन्तरलवेषु हि ॥ ३४ ॥

युक्तैव संस्कृतिः, किन्तु विक्षेपनतिखण्डयोः ।

मिथो योगो वियोगो वा नोपपन्नो भवेत् तदा ॥ ३५ ॥

यतो नतिः क्षेपवृत्ततिरश्चीनैव तन्मते ।

क्रान्तिवृत्ततिरश्चीनो विक्षेपः सर्वसम्मतः[17] ॥ ३६ ॥

एवं ह्युभयतःपाशारज्जुरत्रापतिष्यति ।

किञ्च गत्योर्वियोगोऽपि पक्षेऽस्मिन् नैव युक्तिमान्[18] ॥ ३७ ॥

भिन्नमार्गगतत्वस्य तयोरप्यविशेषतः ।

33*b*-34*a*. (v) If however, in order to remove this objection, the parallaxes in latitude (*nati*) and longitude (*lambana*) and their variations (*khaṇḍas*) be calculated according to the method prescribed by Bhāskara,

34*b*-36. then, the rectification (*saṁskāra*, addition or subtraction) of the variation in longitude by the variation in parallax in longitude is permissible ; but addition or subtraction between variations in latitude (*vikṣepa-khaṇḍa*) and variation in parallax in latitude (*nati-khaṇḍa*) will not be possible, for, according to Bhāskara, the parallax in latitude is [measured] perpendicularly to the Moon's orbit, and the latitude is [measured], according to all, perpendicularly to the ecliptic.

37*a*. Thus, [according to this school], every approach leads us to a dilemma.

37*b*-38*a*. (vi) Again, according to this school, even the subtraction of the velocity of one from the other is not possible because the two are [measured], along different paths.

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16. The reference is to the combination of नति and विक्षेप enunciated by Bhāskara I in his *Mahābhāskarīya*, V. 27-28.

17. A. has a gap here ; it reads विक्षेप......स्सर्वतः ।

18. B. युक्तिमत् ।

"लग्नोनान्त्येन्दुदोःकोट्यो"[19]रित्यादाविन्दुलग्नयोः ॥ ३८ ॥

वियोगोऽपि न युक्तोऽत्र यतस्तौ भिन्नवृत्तगौ ।
किञ्चात्र "कृतनत्येन्दोः क्षिप्त्यानीतं स्थितेर्दलम् ॥ ३९ ॥

कृत्वा तत्काललम्बं च पर्वान्ते निर्णयस्तयोः"[20] ।
इत्युक्तस्थितिदलस्यानीतिरपि न युज्यते ॥ ४० ॥

यतः स्थितिदलक्षेत्रगतिभेदांशरूपयोः ।
इच्छाप्रमाणयोर्नात्र वस्तुतस्तुल्यरूपता ॥ ४१ ॥

तस्माद्विधोरन्त्यभुक्तिरन्त्य[21]स्फुट इति द्वयम् ।
क्रान्तिवृत्तानुसार्यैव स्वीकर्तव्यं रविग्रहे ॥ ४२ ॥

38*b*-39*a*. (vii) Then again, according to this school, the subtraction between the Moon and the rising point of the ecliptic (*lagna*), as required in the [verse] beginning with, "of the *bhujā* and *koṭi* of Final-Moon-minus-lagna", is also impossible, because the two move in different circles.

39*b*-41. (viii) Now there is the rule : Calculate the half-duration of the eclipse (*sthiter-dala*) from the Moon's latitude as corrected for parallax, (*kṛta-natyā kṣiptyā*) ; calculate also the parallax in longitude (*lamba*) for the times (*tat-kala*) obtained, (*viz.* the beginning and end of the eclipse); and thus determine them (?) at conjunction."

The calculation of the half-duration of the eclipse according to this rule is also not possible, since, really, there is no similarity between the fields on which the half-duration and the relative variation in motion are represented, (*viz.*, the ecliptic and the Moon's orbit) which form, respectively, the consequent (*icchā*) and the antecedent (*pramāṇa*).

42. Therefore in the Solar eclipse, the two, the rectified velocity of the Moon (*antya-* or *saṁskṛta-bhukti*) and latitude corrected for

19. *Uparāga-kriyākrama*, III. 28 ff.
20. *Uparāga-kriyākrama*, III. 41.
21. A. has a gap in the place of रन्त्य.

[22]तथा च सूर्यशशिनोर्गत्योश्च स्फुटयोरपि ।
विश्लेषो युज्यते तद्वद् भुजाद्यानीतिरेव च ॥ ४३ ॥

क्रियाक्रमे त्वन्त्यभुक्तिरपि विक्षेपवृत्तगा ।
गृह्यतेऽतो भुजादीनामानीतिर्नातिसुन्दरा ॥ ४४ ॥

राशिगोलस्फुटैक्यं हि यदा स्यादर्कचन्द्रयोः ।
स एव कालः पर्वान्तो ग्राह्यः सूर्यग्रहे सदा ॥ ४५ ॥

अन्यथा लम्बसंस्कारः पर्वान्ते नैव युज्यते ।
क्रान्तिवृत्तकलारूपाः यतो लम्बनलिप्तिकाः ॥ ४६ ॥

[राशिगोलस्फुटसंस्कारः]

इन्द्वादीनामपि गतिः क्रान्तिवृत्तानुसारिणी[23] ।

parallax, have to be measured only in relation to the ecliptic, [the former along it and the latter perpendicular to it.]

43. Again, it would be proper to take the differences between the velocities of the Sun and the Moon and that between their rectified latitudes and so also in the matter of the determination of the sines etc.

44. In the *Kriyākrama*, the rectified velocity too is measured along the (planet's) orbit, and hence the derivation of the sines etc. is not quite accurate.

45. In the solar eclipse, that moment alone is to be taken as the moment of conjunction when the rectified latitudes of the Sun and the Moon on the celestial sphere (of which the ecliptic is a great circle) are identical.

46. Otherwise, corrections for parallax would not be correct at the moment of conjunction, for the seconds of parallax (*lambana-liptāḥ*) are in terms of the seconds of the circle of the ecliptic.

22. A. Omits. verses 43-46.

23. B. गतिः गृह्यते राशिगोलगा ।

अतो न क्षेपतो भेदः स्फुटस्यापीति यन्मतम्[24] ॥ ४७ ॥
समलिप्ताकाल एव पर्वान्तस्तन्मते भवेत् ।
चन्द्रादयः क्षेपवृत्ते भ्रमन्ति सततं यतः ॥ ४८ ॥

ततः स्फुटोऽपि तेषां स्यात् स्वतोऽपि क्षेपवृत्तगः ।
इति पक्षे हि पर्वान्तः साम्यकालो न केवलम् ॥ ४९ ॥

[26]अस्मिन् पक्षे हि चन्द्रस्य राशिगोलस्फुटाप्तये ।

(Correction for Reduction to the Ecliptic)[25]

47-48*a*. Now, according to the view of those who consider that the true motions of the Moon and the other [planets] are given [by the *Śāstrakāras*] along the ecliptic, and hence their true longitudes are not vitiated by their orbital motion (*kṣepataḥ* means *kṣepa-vṛtta-gamanataḥ*), the moment of equality in degrees will itself give the moment of conjunction (*parvānta*).

49*b*-50. On the other hand, according to the view that since the Moon and other [planets] always move on [their own] orbits (*kṣepa-vṛtta*)

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24. A. यन्मतौ: B स्फुटस्येति हि यन्मतम् ।

25. Having established that measurement of longitude and latitude are to be made only with reference to the ecliptic, the former along it and the latter perpendicular to it, the text takes up another question, whether a correction is necessary to the orbital longitude of the Moon in view of the fact that it actually moves along its orbit and its longitude is measured on the ecliptic. On this question there might be a school who would consider that the rules for calculating the longitude given by the *Śāstrakāras* include this correction ; for them no more correction would be necessary. But if it is be viewed that the basic textbooks (*Śāstras*) give the true-longitude (*sphuṭa*) only along the respective orbits, a correction called the 'Reduction to the Ecliptic' is necessary, which might be expressed by the term *Rāśigolasphuṭanīti*, in a restricted sense. Obviously, Acyuta is one who deems the correction necessary.

26. B. reads the verse as :

अस्मिन् पक्षे हि चन्द्रस्य स्फुटीकरणतः परम् ।
राशिगोलस्फुटाप्त्यै हि कार्यं यत्नान्तरं बुधैः ॥

स्फुटीकरणतः पश्चात् कार्यं यत्नान्तरं यतः ॥ ५० ॥

तत्प्रकारश्चाच्युतेन कीर्तितः स्फुटनिर्णये[27] ।

"पातोनस्य विधोस्तु कोटिभुजयोर्जीवे मिथस्ताडये-

दन्त्यक्षेपशराहतं वधममुं विक्षेपकोट्या हरेत् ।

[28]लब्धं व्यासदलोद्धृतं हिमकरे स्वर्णं, विपाते विधौ

युग्मायुग्मपदोपगे ; विधुरयं स्पष्टो भगोले भवेत्" ॥ ५१ ॥

[29]इत्यत्र वासना ज्ञेया कलास्वन्तरवद् बुधैः ॥ ५२ ॥

and hence their true longitudes (*sphuṭa*) are [measured] on their orbits, the moment of conjunction is not equality in degrees [measured on the ecliptic].

50-52. It is because, according to this view, a further correction has to be applied to the true longitude [as measured on its orbit] to obtain the true longitude as measured on the ecliptic (*rāśigola-sphuṭa-aptaye*), that a method to this effect has been enunciated by Acyuta in the *Sphuṭanirṇaya.*

"Multiply the tabular cosine (*koṭijyā*) and sine (*bhujājyā*) of Moon-minus-Node and the product by the tabular versine (*śara*) of the maximum latitude (*antya-kṣepa*) of the Moon. Divide this by the tabular cosine of the latitude at the particular moment and the quotient is to be divided again by the tabular radius (*vyāsa-dala*). The result [will give the correction for longitude which] is to be added to, or subtracted from, the moon's longitude, as Moon-minus-Node is in an even or an odd quadrant, respectively. The True-Moon measured on the ecliptic is thus got."

The proof for this may be understood by wise men learned in the (nuances of astronomical) science (*kalāsu*).

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27. The verse next quoted is *Sphuṭanirṇaya*, IV. 2. See Introduction, pp. 12-14, for the trigonometrical verification of the correction of Reduction to the Ecliptic enunciated here.

28. A.B. read लब्धाद्. The better reading लब्धं is from the original *Sphuṭanirṇaya.*

29. B. omits the further verses, but has a discussion on this verse which is edited below as Appendix I.

अयमेव हि संस्कारो लघूकृत्य क्रियाक्रमे ।
तेनैव "क्षेपवीरांशं कुर्याद्" इत्यादिनेरितः[30] ॥ ५३ ॥

राशिगोलस्फुटानीतिरच्युतेनैवमीरिता[31] ।
क्रान्तिवृत्तगतिश्चैवमानेया गोलवित्तमैः ॥ ५४ ॥

[इत्यच्युतमतानुसारिणी राशिगोलस्फुटानीतिः ॥]

53. This very correction has been enunciated in a simplified form by the same [author] in [his *Uparāga-*]*Kriyākrama* in the words "Apply one twenty-fourth part of the latitude" etc.

54. Thus has been enunciated the "True-longitude Computation on the Sphere of Zodiac" by Acyuta. True longitudes [of planets] on the ecliptic should be calculated by experts in this manner.

[THUS ENDS TRUE-LONGITUDE COMPUTATION
ON THE SPHERE OF ZODIAC
ACCORDING TO ACYUTA]

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30. The reference is Acyuta's *Uparāga-kriyākrama,* ch. I. 41 :

पर्ववत् 'क्षेपवीरांशं कुर्या'च्चन्द्रे स चन्द्रमाः ।
परमग्रासकाले स्वे स्यात् पर्वान्ते रविग्रहे ॥

For a mathematical demonstration of this formula, see above, Introduction, pp. 15-16.

31. A.B. have ईरितम् in the neuter,

APPENDIX I

राशिगोलस्फुटसंस्कारविवेचनम्

DISQUISITION ON REDUCTION TO THE ECLIPTIC

'पातोनस्य विधोस्तु' इत्यादिश्लोकस्य वासना

पातोनस्य विधोस्तु कोटिभुजयोर्जीवे मिथस्ताडयेद्
अन्त्यक्षेपशराहतं वधममुं विक्षेपकोटया हरेत् ।
लब्धं व्यासदलोद्धृतं हिमकरे स्वर्णं, विपाते विधौ
युग्मायुग्मपदोपगे; विधुरयं स्पष्टो भगोले भवेत् ॥

[1]अत्र वासना प्राणकलान्तरवत् ज्ञेया । कथं पुन: राशिगोलस्फुटगत्या-नयनमिति चेत् उच्यते । पातोनेन्दुं द्विगुणीकृत्य तत: कोटिज्यामानीय तया स्फुटगतिं हत्वा क्षेपकोटया हरेत् । तत्राप्तं अन्त्यक्षेपशरेण हत्वा त्रिज्ययाप्तं फलं द्विघ्नस्य पातोनेन्दो: कर्किनक्रादिवशाद् गतौ धनमृणं वा कुर्यात् । तदा इन्दो: क्रान्तिवृत्तस्फुटगतिर्भवति । एवं सामान्येन इन्दो: राशिगोलगतस्फुट-गत्योरानयनमुक्तम् ।

उपरागे तु गुणकारभूताया व्यहीन्दुकोटया हारभूताया: क्षेपकोटयाश्च प्रायेण त्रिज्यातुल्यत्वनियमात् ताभ्यां न किञ्चित् कृत्यमस्ति । अतस्तदानीं अन्त्यक्षेपशरो गुणकार: । स च **अच्युतमते** प्रायेण द्वादशसंख्य: । तत्र व्यासार्धे द्वादशभिर्हृते सति हारक: स्यात् । स चाक्षरसंख्यया 'सुन्दर' (२८७) इति भवति । तदेवं व्यहीन्दुदोर्ज्या'सुन्दरां'शस्फुटान्तरं गति:, 'सुन्दरां'शो गत्यन्तर-मिति च स्थितम् ।

तत्र यदि विक्षेपात् स्फुटान्तरमानीयते तर्हि विक्षेपस्य व्यहीन्दुदोर्ज्या-'रम्यां'शत्वात् 'सुन्दररम्यां'शो हारको ग्राह्य: । स च चतुर्विंशतिसंख्य: ।

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1. The following disquisition occurs in the manuscript of *Raśigolasphuṭānīti*, No. 755 (G) of the Kerala Univ. Or. Res. Inst. and Mss. Library, Trivandrum, in continuation of the verse **पातोनस्य विधोस्तु** etc.

एतत्सर्वमभिप्रेत्य हि [अच्युतकृते उपराग-]क्रियाक्रमे 'पर्ववत् क्षेपवीरांशं' (I.42), 'युगयुक्पदजात् क्षेपाद् वारांशाप्तं स्वमृणं क्रमात्' (II. 6) इत्याद्युच्यत इति ध्येयम् ।

एतत्स्फुटान्तरसम्बन्धिकालानयने पुनरिदं त्रैराशिकम् — यदि गत्यन्तरांशतुल्याभिः षष्टिर्विनाड्यो लभ्यन्ते तदा 'क्षेपवीरांश'तुल्याभिः कति विनाड्य इति । अत्र विक्षेपस्य षष्टिर्गुणकारः, चतुर्विंशतिर्हारकः । एतौ द्वादशभिरपवर्तितौ क्रमात् पञ्चसंख्यो द्विसंख्यश्च भवतः । तदुक्तं—

युगयुक्पदजात् क्षेपात् पञ्चघ्नाद् द्विघ्नगतिभिदांशाप्ताः ।
विघटीः स्वमृणं कुर्यात् पूर्णान्ते व्यत्ययेन दर्शान्ते ॥

(उपरागक्रियाक्रमः, I. 41)

इति । अत्र हि शशिग्रहे नतिलम्बनयोरभावात् विक्षेपवृत्तरूपैवेन्दोस्तत्काल-सरणिः । ततश्च अर्कबिम्बाक्रान्तक्षेपपार्श्वाख्यवृत्तं यदा चन्द्रः प्राप्नोति तदैव परमग्रासः । स च व्यहीन्दौ युक्पदगे साम्यकालात् प्रोक्तविनाडिकाभिः पश्चात् स्यात् । अयुक्पदगे तु प्राक् ।

सूर्यग्रहणे तु पूर्वोक्तयुक्तिभिः इन्दोरर्ककलाप्राप्तिकाल एव पर्वान्तत्वेन ग्राह्यः । स च व्यहीन्दौ युक्पदगे साम्यकालात् प्राक्, अयुक्पदगे पश्चात् । अत उक्तं—'व्यत्ययेन दर्शान्ते' इति । तस्मात् वर्त्मसाम्यं हि पर्वान्त इति पक्षे (*Cf.* राशिगोल., 4-6) विधोर्गतिः क्षेपवृत्तानुसारी स्यात् । 'ततोऽस्या बाहुता कथम्' (राशिगोल., 25a) इत्यारभ्य क्रियाक्रममते सूर्यग्रहणे यानि दूषणान्युक्तानि तत्सर्वं निराकरणीयमिति यद्याग्रहः तर्हि प्रथमाध्यायान्ते—

सोऽयं संस्कृतशीतांशुराद्योऽन्त्यः समलिप्तिकः ।
तद्गतिर्निजसिन्दूरभागोना च रविग्रहे ॥

इति वक्तव्यं स्यात् । अस्मिंश्च पक्षे विक्षेपानयने—

व्यहीन्दुदोर्ज्या रम्याप्ता लम्बहारकताडिता ।
युद्धार्थाप्ता युता क्षेपो लिप्ताद्यंशविलिप्तया ॥

(*Cf.*, उपरागक्रियाक्रमः, I. 39)

इति पाठः कार्यः । लम्बनविनाडीसंस्कारे च—

इन्द्वोर्मध्यगतिघ्न्यः प्राक् लम्बहारविभाजिता ।

(*Cf.*, उपरागक्रियाक्रमः, III. 13)

इति पठनीयम् ।

किञ्च एवं इष्टग्रासानयने 'केवलक्षेपवीरांश'संस्कारो न कार्यः। ततश्च तत्कालदृग्गतेर्भेदहाराप्ता लम्बनलिप्तिकाः कृत्वा इन्दौ तेन तत्तत्काल-भानोः कार्यं स्फुटान्तरम् इत्येव इष्टग्रासविधौ वक्तव्यं स्यात्। चन्द्रग्रहणे तु विक्षेपवृत्तगतगत्योरन्तरमेव ग्राह्यम्। तच्च अर्कगति'सुन्दरां'शयुतकेवलगत्य-न्तरमेव। न चैवं स्थित्यर्धानयनानुपपत्तिः शङ्क्या, स्थित्यर्धकोट्या अपि क्षेपवृत्तगतया एव स्वीकारात्।

ननु इन्दोः स्फुटं द्वयमपि स्वतो विक्षेपवृत्तगतमेव। ततश्चाद्येन्दो-रानीतः क्षेपः क्रान्तिवृत्ततिरश्चीन एव स्यात्।

इष्टाग्रगा त्विह वृतिद्वययोगमूला
दोर्ज्येष्टमण्डलगता खलु कर्णरूपा।
दोर्ज्याग्रकेऽन्यवृतिपार्श्वकयोस्तथैव
स्पृष्टे तु मण्डल इहाभिमतान्तरालम्॥

इति न्यायात्।

एवं च इन्दुमार्गविक्षेपयोर्मिथो दोःकोटित्वाभावात् स्थित्यर्धकोट्या इन्दुमार्गगतत्वं न संभवत्येवेति चेन्मैवम्। न ह्यस्मिन् पक्षे मध्यकालजेन्दुस्फुटा-दानीतविक्षेपेण स्थित्यर्धकोटिरानीयते, येन उक्तदोषः स्यात्। किन्तु मध्य-कालीनबिम्बान्तरेणैव। तच्च इन्दुमार्गविपरीतदिक्कमेवेति न किञ्चिद-समञ्जसम्।

यद्यस्मिन् पक्षेऽपि सम्पर्कार्धमण्डलस्यार्कगत्या चलनात् तत्कालार्कात् पातं विशोध्यानीतक्षेपेणैव स्थित्यर्धमानेयमिति युक्तितः स्थित्यर्धस्याविशेषणं कार्यमेव। तथापि इह मध्यकालक्षेपात् स्पर्शमोक्षजार्कादानीतक्षेपयोर्भेदस्या-ल्पत्वात् ततोऽल्पतर एव स्थित्यर्धभेद इतीह अविशेषाकरणेऽपि न दोषः। एतदेव ह्यभिप्रेत्य **क्रियाक्रमे** चन्द्रग्रहणे स्थित्यर्धस्याविशेषणं नोक्तमिति ध्येयम्।

एवमिष्टग्रासानयनेऽपि यदि तत्कालार्काद् विक्षेप आनीयते तर्हि स्फुटान्तरानयनार्थं चन्द्रे 'क्षेपवीरांश'संस्कारो न कार्यः। ततश्च—

मध्येष्टकालविश्लेषनाडीर्गत्यन्तरांशकैः।
हत्वा तद्वर्गयुक्तेष्टार्कोत्थया इष्टक्षेपकृतेः पदम्॥
बिम्बान्तरं तदूनं स्यान्मानैक्यार्धं तदा ग्रहः॥

इत्येवमिष्टग्रासानयनकर्म स्यात्, अथवा 'इष्टघ्नेनेष्टकालजम्' इत्यत्र 'इष्टार्कात्त्विष्टजे ग्रहे' इति वा पाठः कार्यः। **सोमयाज्युक्तपद्येष्वपि** आद्यश्लोके 'सगतीनानयेत् सायनांशान्' इत्यतः पश्चात्—

किन्त्वर्कस्योपरागे विधुचरमगतिः स्यात् सुवारांशहीना,

ग्राह्या चन्द्रोपरागे रविगतिसवरांशान्वितो भुक्तिभेदः ।

इत्युत्तरार्धं पाठ्यम् ।

पुनः 'नाभिघ्ना'दित्यादि द्वितीयश्लोकः । तत्रापि—

बाल्यः सूर्योपरागे चरमहिमकरः सूक्ष्मपर्वान्तकाला-

वाद्येन्दुः साम्यकालावुभयमपि पुनः ग्लौग्रहे साम्यकालात् ।

इत्युत्तरं बोध्यम् ।

ननु ग्रहणगणने 'पर्वान्तः', 'समलिप्ता' चेति द्वौ पदार्थाविव लेखनीयत्वेन प्रसिद्धौ । इह तु 'साम्यकाल'स्यापि लेखनीयत्वात् गौरवमिति चेत् न । यथा-स्थितपाठेऽपि तस्य लेख्यत्वात् । **क्रियाक्रमे** तु चन्द्रोऽपि स्फुटपर्वान्ते नीत इति यद्यपि साम्यकालेन न प्रयोजनं, तथापि तत्कालार्कस्यापि ज्ञेयत्वेन लेखनेन लाघवातिशयः । प्रत्युत 'क्षेपवीरांश'संस्काररूपं क्रियागौरवमधिकमिति दिक् ।

नन्वेवमपि गतिसंस्कारोऽत्राधिक इति चेत् न । इष्टग्रासे व्यहीन्दु-दोः'सुन्दरांश'संस्कारस्येह अकरणीयत्वेन लाघवस्यापि सत्वात् । तस्मान्न किञ्चिद् गौरवम् । अत एव हि **लघुभास्करीयव्याख्याने पारमेश्वरे** इन्दुमार्गगत-स्थित्यर्धक्षेत्रसिद्ध्यर्थं स्थित्यर्धानयने मध्येष्टविक्षेपयोरेकदिग्गतत्वे अन्तरवर्गं, भिन्नदिक्त्वे तयोर्योगवर्गं च विक्षेपवर्गहीनसम्पर्कार्धकृतौ प्रक्षिप्य मूलीकरणं कार्यमित्युक्तम् (*Cf.* लघुभा. व्याख्या, IV.12, ed., *Anandasrama Skt. Ser.*, No. 128, Poona, 1946, p. 51).

APPENDIX II

INDEX OF AUTHORITIES CITED

APPENDIX III

INDEX OF HALF-VERSES AND PASSAGES CITED

[*Note*: The numbers refer to the verses, their first and second halves being distinguished by 'a' and 'b', respectively. References to pages are prefixed with 'p'.]

CHAPTER X

TANTRASAṄGRAHA OF NĪLAKAṆṬHA SOMAYĀJI

('EPITOME OF THE SCIENCE OF ASTRONOMY')

With two Commentaries *Yuktidīpikā* and *Laghuvivṛti*

Critically edited with

Introduction and Four Appendices

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IV. चन्द्रग्रहणप्रकरणम्

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TANTRASANGRAHA WITH LAGHUVIVṚTI

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(ELEVATION OF THE LUNAR HORNS)

INTRODUCTION

1. INTRODUCTORY

The *Tantrasaṅgraha* is a major work of Nīlakaṇṭha Somayāji (A.D. 1444-1545), one of the eminent Kerala astronomers of mediaeval times. It is a full-fledged text on Hindu astronomy which deals, in eight chapters, with the more important aspects of the discipline, including the Mean and True planets, Gnomonic and related computations, Lunar and Solar eclipses, the phenomenon of *Vyatīpāta* when the Sun plus Moon is equal to 180°, Reduction to observation of planetary positions (*Dṛkkarma*) and the Elongation of the Moon's horns (*Candra-śṛṅgonnati*). It incorporates also new methodologies and corrections introduced by the author towards accurate astronomical computation. The text of the *Tantrasaṅgraha* is edited here critically, along with two commentaries, of which the first commentary called *Yuktidīpikā* gives an elaborate exposition of mathematical and astronomical concepts and computations, in simple verses. Since, however, this commentary extends only through chapters I-IV, a second commentary called *Laghuvivṛti* has been added for the rest of the work. This latter commentary, which is concise and matter of fact, has already been issued through the *Trivandrum Sanskrit Series*, No. 188, (Trivandrum, 1958), but in the present publication, its edition has been made more reliable and critical by the employment of two highly accurate manuscripts.

2. MANUSCRIPT MATERIAL

2.1. Manuscripts of the Text of Tantrasaṅgraha (TS)

Twelve manuscripts, in all, have been used towards the critical edition of the textual verses.

A. Ms. 3810 of the Vishveshvaranand Institute Library, Hoshiarpur. This is a palmleaf manuscript, inscribed in Malayalam script, in 195 folios, 21 cm. × 3·5 cm., having 7 to 8 lines a page, with about 25 letters a line. It is written in two or three hands, the lettering of all of which is clear and shapely. The writing has been inked and has

undergone the scrutiny of a reviser whose occasional corrections can be detected by their not being inked. The manuscript is in good preservation, though the corners have rounded off by frequent use. The manuscript is not dated nor any scribe mentioned, but its original repository is given as 'Vāraṇāsi', a reputed family of Nampūtiri brāhmins in Central Kerala.[1] At the close of the work, some miscellaneous matter has been inscribed on three folios. The manuscript contains the text of *Tantrasaṅgraha* and its commentary *Laghuvivṛti*, both complete and to a high degree of accuracy.

B. A paper transcript of a palmleaf manuscript in Malayalam script preserved in the Sanskrit College Library, Tripunithura (Kerala), Ms. No. 543-B, prepared by the late Rama Varma Maru Thampuran of the Cochin royal family in 1941 and later passed on by him to the present editor. The manuscript is not dated ; neither has any scribe been mentioned. It contains a highly accurate text of the *Tantrasaṅgraha* with the commentary *Laghuvivṛti*. The codex contains also several short works on astronomy.

C. 1-10. Ten palmleaf manuscripts, all in Malayalam script, containing both the text and the commentary *Laghuvivṛti*, had been used in the preparation of the edition thereof through the *Trivandrum Sanskrit Series*, No. 188, (Trivandrum, 1958), and designated क to ञ. While the present edition of the textual verses is primarily based on the two highly reliable manuscripts A and B noticed above, the variant readings that occurred in the ten manuscripts and recorded in the said edition have been noted here with the *sigla* C_1 to C_{10} .

2.2. Relationship of the Text manuscripts

The readings of the manuscripts A and B are not only accurate and almost free from scribal errors and other lapses, but also almost identical. Stray differences, however, rule out the possibility

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1. *Vide* the expression 'Vāraṇāsi' inscribed in Malayalam letters on the wooden covering board of the ms. and *Vāraṇāsiye Kriyākalāpam Tantrasaṅgraha-vyākhyānam*, meaning 'The *Kriyākalāpa* : *Tantrasaṅgraha*-commentary belonging to Vāraṇāsi', on the reverse of the final folio of the manuscript.

of one being a copy of the other. C_{1-10} do not form a uniform group ; manuscripts C_9 and C_{10}, either individually or, together, align with A and B.

2.3. TS Commentary in verse

Four manuscripts, described here-in-below, were used for the edition of this commentary.

A. Ms. No. R. 2505 of the Govt. Oriental Mss Library, Madras, being a paper transcript in Devanāgarī (278 pages, 25 cm. × 22½ cm., 20 lines a page with 16 letters a line), copied in 1918 from a palmleaf manuscript in Malayaḷam script which belonged to the Deśamaṅgalam Manakkal, a house of scholarly Nampūtiri brāhmins in Central Kerala. The writing is not quite free from errors, and minor lapses are frequent. The manuscript contains only the commentary and not the text, and extends upto the end of ch. IV.

B. Ms. No. C. 1375 of the Oriental Res. Institute and Mss. Library, Kerala University, Trivandrum, in 113 ff., 35 cm. × 5 cm. This is a palmleaf manuscript in Malayalam script, of which there is a paper transcript also in the said Library, being No. T. 746. The writing is beautiful and the text preserved is generally free from errors. No scribe is mentioned nor any date indicated. Only the commentary is available herein and not the text. The manuscript belonged to Shri Tuppan Tuppan Nampūtiri of Ponnorkkoṭṭu Mana, in Central Kerala. The manuscript is well preserved and is tied up between lacquered wooden boards bearing floral designs in red, black and green. One stray leaf at the end, which is smaller in size, carries a short astronomical work in nine verses, *kṛtadvighnāyana* ... (verse 1), *gānādīm ca* ... (verse 2) etc.

C. Ms. No. 16932-B of the said Kerala University Mss. Library. This is a palmleaf manuscript containing the commentary of chs. I-IV, in 86 folios, 40 cm. × 5¼ cm., having 12 lines a page, with about 48 letters per line. It is well preserved but worm-eaten at places. The writing is bold and clear but abounds in scribal errors and other lapses, possibly on account of the not-so-clear writing in its archetype. A flyleaf carries the name of the original owner of the codex as the scholarly principality of Kiḷimānūr, near Trivandrum, in South Kerala : *Kiḷimānūr koṭṭāram vaka Tantrasaṅgraham*, 'The Tantrasaṅgraha of the Kiḷimānūr palace'. The codex contains another work, being the textual verses of

the *Tantrasaṅgraha*, in 13 folios in the beginning, which is numbered 16932-A.

D. Ms. No. 586-E of the said Kerala University Mss. Library, procured from a house of learned scholars in Central Kerala, being the Kūṭallūr Meleṭattu Mana as indicated in a stray leaf in the codex. It is a miscellaneous palmleaf manuscript (30 cm. × 5 cm.) containing five works on different subjects, in different hands. The manuscript is old and brittle and the corners have worn off by use. *Tantrasaṅgraha-vyākhyā* is inscribed as the last work in the codex in 15 folios, having 8 lines a page, with about 56 letters a line. No scribe is mentioned nor is the manuscript dated. The text preserved is generally correct but breaks off abruptly towards the middle of the commentary on verse I. 26 (*vide* p. 35 of the edition below); obviously its archetype ended there.

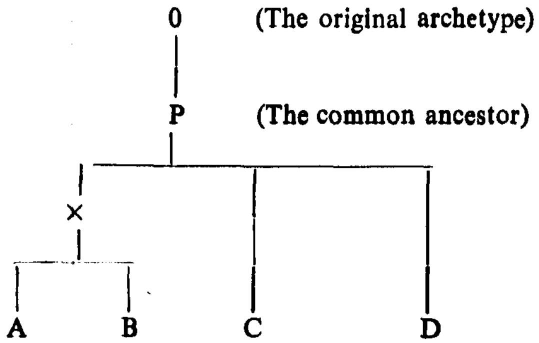
Still another manuscript of the work, in palmleaf, inscribed in the Malayalam script and containing chs. I-IV, is known to exist in the Ponnorkoṭṭu Mana, P.O. Peringode, S. Malabar. This manuscript had, at one time, been on loan to the Kerala University Mss. Library (L. 1302), but was returned to the owner long back, in 1956, and the efforts made to procure it for use in the present edition did not bear fruit. It is a consolation that the four available manuscripts were adequate enough to prepare a reliable edition of the work and that the nonavailability of the fifth manuscript did not result in any serious difficulty.

2.4. Relationship of the manuscripts of the Com. in verse

While all the four manuscripts used, **A**, **B**, **C** and **D**, bear a uniform text, minor variations establish their mutual independence. A few, but common lacunae and errors point to a common ancestor which contained those defects.[1] On the basis of mutual differences and similarities, manuscripts **A** and **B** could be taken to form one group while **C** and **D** form separate derivatives. In consideration of the

1. See, for example, com. verses, I. *151, 176, 376, 417, 455,* 512, 645, 820 ; II. 31, 34, 185, 287, 372, 468, 473, 491, 654, 725, 39, 786.

above, the pedigree of the manuscripts can be represented by the following *Stemma codicum* :



2.5. Commentary Laghuvivṛti

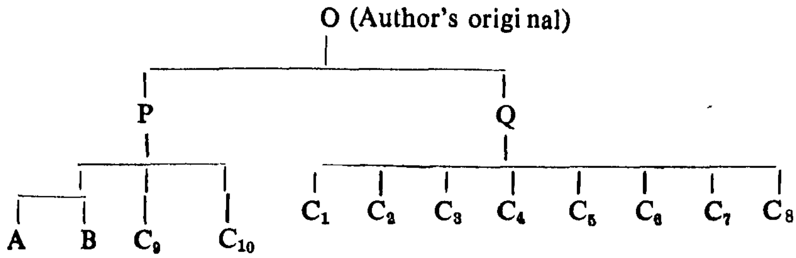
Twelve manuscripts of the commentary *Laghuvivṛti*, all in palmleaf, and inscribed in Malayalam script, have been used for the constitution of its chapters V-VIII, edited here-in-below. These manuscripts are the same as the twelve Text manuscripts A, and B and $C_{1\text{-}10}$, described above, which contain both the textual verses and the commentary. They are designated by means of the same *sigla*.

2.6. Relationship of the manuscripts of Laghuvivṛti

As in the case of the textual verses, while the *Trivandrum Sanskrit Series* edition of the commentary *Laghuvivṛti* has been duly consulted and the variants recorded therein as footnotes taken due note of, the edition of the *Laghuvivṛti* presented here had to be based primarily on the two manuscripts **A** and **B** for very pertinent reasons. First, **A** and **B** were, both, largely free from scribal and other errors and contained a more accurate text than that presented in the *TSS* edition ; in fact, these two mss. helped in the correction of numerous lapses that had crept into that edition. Secondly, the readings in these two manuscripts were practically identical and uniform, indicating their being the representatives of a definitive version of the commentary. The readings in two of the manuscripts used for the *TSS* edition, being C_9 and C_{10}, as recorded in the footnotes to that edition, very often followed those of **A** and **B**, but not always, possibly because the parallels in them were not fully recorded in the footnotes. The other manuscripts used for the *TSS* edition have

additional or different passages from A and B[1] and, so, represent a different version of the commentary. It was, therefore, felt that by closely following A and B, the present publication would be placing before scholars a version of the commentary different from that issued through the *TSS* edition.

The pedigree of the twelve manuscripts of *Laghuvivṛti* can be represented as follows :



3. TEXTUAL PRESENTATION

In the critical edition of the *Tantrasaṅgraha* and its two commentaries in this publication, special care has been taken to present the material in as intelligible and handy a manner as possible for the modern scholar, towards which the undermentioned editorial innovations have been adopted.

(i) The textual verses have been printed in bold black type and placed at the top of the pages, separated by a line from the commentary which is printed below in smaller type.

(ii) Textual and commentarial footnotes have been differentiated for their easier identification, by prefixing them, respectively, by the terms *mūlam* and *vyākhyā*.

(iii) Textual expressions (*pratīka-s*) occurring in the commentary have been set off by difference in typography.

(iv) Names of authorities cited and external quotations occurring in the commentaries have also been similarly set off through difference in typography.

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1. For additional passages in C, see below. pp. 292, 294, 297, 318, 343. And, for different passages, see pp. 290, 297, 319.

(v) Efforts have been made to trace the quotations to their sources and indicate the references thereof.

(vi) Numbers expressed through 'literary phrases' in the text and the commentaries have been converted also into numerical figures and placed alongside the said expressions for easy comprehension.

(vii) Appropriate subject headings have been added, within square brackets, to the numerous topics dealt with in the text and in the commentaries. While including the said headings in the Contents, at the begining of this publication, their English renderings have also been given.

(viii) In order to facilitate easy reference to the elaborate commentary on chapters I-IV, which is exclusively in verse, the commentarial verses of each chapter have been numbered consecutively.

(ix) Three Appendices have been added to the edition with a view to facilitate easy reference to the contents of the book. In Appendix I, in addition to the half-verses of *Tantrasaṅgraha,* all such key passages which express full ideas and, so, are amenable to be quoted elsewhere, have been indexed. Appendix II forms an index of the authorities cited in the text and the commentaries. The third Appendix is a General Index of the numerous subjects treated by the author and the commentators. It might be noted that English equivalents have been provided for the technical terms included in the Index.

4. AIM OF THE PRESENT EDITION

As mentioned earlier, the *Tantrasaṅgraha* of Nīlakaṇṭha has already been made available in published form with the commentary *Laghuvivṛti.* That being the case, what prompted the present undertaking was the vast material on mathematical and astronomical rationale that lies enshrined in the hitherto unpublished and little-known commentary in verse on *Tantrasaṅgraha* which is published for the first time in the present volume. It would seem that, more than commenting on the text of the *Tantrasaṅgraha,* the commentator was more concerned with the exposition of the broad conceptions and the methodologies of mathematics and astronomy as understood and practised in Kerala during his times. To him, the *karikās* of the *Tantrasaṅgraha* were no more than pegs on the wall to spread out the canvas of his mathematical acumen. Perhaps this is the most elaborate work in Sanskrit, so far known, which

pictures the mental working of the Hindu mathematician and astronomer of mediaeval times.

5. NILAKAṆṬHA, AUTHOR OF TANTRASAṄGRAHA

5.1. Biographical details

Nīlakaṇṭha is generally referred to with the title *Somayājī*, *Somasut*, *Somasutvan* or *Comātiri*, the last being the Malayalam derivative of the Sanskrit word A detailed colophon occurring at the end of his *Bhāṣya* on the *Gaṇitapāda* of the *Āryabhaṭīya*, contains a good deal of information about him : इति श्री-कुण्डग्रामजेन गार्ग्यगोत्रेण आश्वलायनेन भाट्टेन केरलसद्ग्राम-गृहस्थेन श्री-श्वेतारण्यनाथ-परमेश्वरकरुणाधिकरणभूतविग्रहेण जातवेदः-पुत्रेण शङ्कराग्रजेन जातवेदोमातुलेन दृग्गणितनिर्मापकपरमेश्वरपुत्र-श्री-दामोदरात्तज्योतिषामयनेन रवित आत्तवेदान्तशास्त्रेण सुब्रह्मण्यसहृदयेन नीलकण्ठेन सोमसुता विरचितविविधग्रन्थेन दृष्टबहूपपत्तिना स्थापितपरमार्थेन कालेन शङ्कराख(?य) निर्मिते श्रीमदार्यभटसिद्धान्तव्याख्याने महाभाष्ये etc.[1]

The above-quoted passage informs that Nīlakaṇṭha belonged to the Gārgya gotra,[2] was a follower of the *Aśvalāyana-sūtra* of the *Ṛgveda* and was a *Bhāṭṭa*. He was the son of Jātavedas and had a younger brother named Śaṅkara. He had an uncle Jātavedas by name and a close friend Subrahmaṇya. He was a performer of the *Soma* sacrifice. He had composed several works on astronomy, in which subject he had made deep and extensive investigations, a fact which is well borne out by his available works.

Some more personal details about Nīlakaṇṭha seem to be forthcoming from a Malayalam work entitled *Laghurāmāyaṇam*.[3] This work describes itself as a work of Rāma, son of Nīlakaṇṭha of the Gārgya-gotra and resident of Kuṇḍagrāma. *Cf.*, the colophon at its end : इति कुण्डग्रामजेन गार्ग्यकुलतिलकेन श्री-नीलकण्ठात्मजेन आर्याम्बा-गर्भसम्भवेन मन्वादिस्मृतिमर्मज्ञ-संस्कृत-द्राविड-भाषा-त्रय-पारीणस्य दक्षिणामूर्तिनाम्नोऽग्रजेन रामेण विरचितं श्रीरामायणं प्रबन्धम् ।

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1. *ABh. Gaṇita*, Ed., *TSS*, No. 101, (Trivandrum, 1930), p. 180.

2. Generally the term *Gārgya* is affixed to his name in references.

3. Ed. P. R. Menon, *Tuñcattu Granthāvali*, No. 3, Tuñcattu Kāryālayam, Chittoor, 2nd edn., 1931.

This Nīlakaṇṭha is identified by the editor of the work with our author.[1] If this identification is correct, Nīlakaṇṭha's wife was named Āryā, and he had two sons Rāma and Dakṣiṇāmūrti, the latter of whom was well versed in the Dharmaśāstras and learned in the three languages, Sanskrit, Tamil and Malayalam. The great Malayalam poet Tuñcattu Ezhuttacchan is said to have been a student of Nīlakaṇṭha. Nīlakaṇṭha is also said to have composed, at the request of a friend, a panegyric in Malayalam on the Goddess Pārvatī, the presiding deity of the temple of Ūrakam in Cochin, in order to ward off the predicted premature death of that friend's daughter.[2] The authenticity of the above work and the sources of the information are, however, not quite certain, and corroborative evidences have to be found before accepting the above statements.

5.2. Native village and favourite deity

Nīlakaṇṭha hailed from Tṛ-k-kaṇṭi-yūr (Sanskritised into Śrī-Kuṇḍa-pura or Śrī-Kuṇḍa-grāma), near Tirur, S. Rly., Ponnani taluk, South Malabar, a famous seat of learning in Kerala during the middle ages. The name of his *Illam*, as the house of a Nampūtiri brahmin is called, was *Keḷallūr* (sometimes spelt also as *Kerallūr* and *Keḷannūr*), Sanskritised into *Keraḷa-sad-grāma* corresponding to the Malayalam word Keraḷa-nall-ūr.[3] Nīlakaṇṭha's house is identified as the present Eṭamana Illam, situated a little to the south of the local temple.[4] It is stated that Nīlakaṇṭha's family became extinct and that the family property was inherited by the nearest relations, *viz.*, the Eṭamana family.[5]

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1. *Vide* P.R. Menon in his article 'Tuñcattu Ezhuttacchan' in the Malayalam monthly *Tuñcattu Ezhuttacchan*, 3 (1952-53) 127-35.

2. *Ibid.* This stotra is published in a collection of stotras in Malayalam script entitled *Stavaratnamālā*, Pt. I.

3. It may be noted that in the expression *Gārgya-Kerala* prefixed to the author's name, the word *Kerala* refers to the name of his house and not to the state, as is sometimes taken.

4. *Cf.*, Vaṭakkumkūr Rajaraja Varma, *History of Skt. Lit. in Kerala*, vol. I, Trivandrum, 1938, p. 384.

5. I am thankful for this information to the late Sri Rama Varma Maru Thampuran, Chalakkudi (Cochin).

Nīlakaṇṭha's favourite deity was Lord Śiva installed in the famous temple at Tṛpparaṅṅoḍ (Sanskrit Śrī-Parakroḍa, also Śrī-Śvetâraṇya) near his village ; *cf.* श्री-श्वेतारण्यनाथ-परमेश्वर-करुणाधिकरणभूतविग्रहेण, in the colophon to the *ĀBh. Bhāṣya* quoted above (p. xxiv).

5.3. Patron, Netranārāyaṇa, and brother Śaṅkara

Nīlakaṇṭha refers to his younger brother Śaṅkara in several places in the *ĀBh.Bhāṣya*. Śaṅkara too seems to have been well versed in astronomy and to have followed his elder brother's studies. Thus, after describing some method on the Rule of three (*Trairāśika*) in his *ĀBh.Bhāṣya, Gaṇita* 26, Nīlakaṇṭha says how his brother who was teaching at the house of his patron explained to the latter some of those theories : *cf.*, अत्र केषांचिद् युक्तयः पुनः अस्मदनुजेन शङ्कराख्येन तत्समीपे अध्यापयता वर्तमानेन तस्मै (नेत्रनारायणाय) प्रतिपादिताः । (*TSS* 101, p. 156).

Nīlakaṇṭha observes at the close of the *Bhāṣya* on the *Golapada* that he was entrusting the *Bhāṣya* to Śaṅkara for its proper propagation. Thus, just before the final colophon, Nīlakaṇṭha says : एवमिदम् अस्माभिर्यथामति व्याख्यातम् ।

नमः स्वयम्भुवे तस्मै यत्प्रसादादिदं कृतम् ।
नमो भगवते तस्मै श्रीमदार्यभटाय च ॥
शिष्यं तत्त्वेन विचार्यार्यभटसूत्रभाष्यमिदम् ।
यदि स न्यायाल्लिप्सेदस्मै दातव्यमेव शङ्कर ते ॥
इति गोलपादव्याख्यानं समाप्तम् ॥

(*TSS* 185, p. 164)

That Nīlakaṇṭha was intimately connected to and was patronised by Kauṣītaki Āḍhya Netranārāyaṇa, known locally as Āzhvāñceri Tamprākkal, the religious head of the Nampūtiri brāhmins of Kerala, is known from several references in his writings. It is also clear that the patron had great esteem for Nīlakaṇṭha's erudition in astronomy, in which subject he too was interested and used to discuss difficult points with Nīlakaṇṭha. Thus, in the discussion on the calculation of the motion of planets (*ĀBh., Kāla*, 22-25), Nīlakaṇṭha says :

कर्णभुक्तिः स्फुटेत्यत्र व्याख्याने पारमेश्वरे ।
व्यासार्धाप्तं कोटिवर्गात् कर्यर्णादाबृणं धनम् ॥

कोट्यां तद्घनयुग्व्यासवलं गतिविधौ श्रुतिः ।
प्रकारान्तरमाहैवं सूक्ष्मभुक्तिप्रसिद्धये ॥
गुरूणां मे पितात्रापि स्थौल्यान्मत्सरिणोविते ।
परमेश्वर-तच्छिष्या नैव .वेलागतिं विदुः ॥
इति कौषीतकी श्रुत्वा नेत्रनारायणः प्रभुः ।
मह्यं न्यवेदयत् तस्मै तदेवं प्रत्यपादयम् ॥
(*TSS* 110, p. 63)

Again, in the long discussion on the calculation of the apparent position of celestial bodies (*ĀBh.*, *Kāla.*, 17-21), speaking on a method to derive the *sakṛt-karṇa*, our author says : अन्यदपि कर्म अस्माभिरुपन्यस्यमानं श्रुत्वा श्राढ्येन कौषीतकिना अनुष्टुभा निबद्धम्—

स्वोच्चोनमध्यमार्कस्य भुजाज्याघ्ना त्रिजीविका ।
स्वोच्चहीनस्फुटार्कस्य दोर्ज्याभक्ता श्रुतिर्भवेत् ॥ इति ॥
(*TSS* 110, p. 47)

This would indicate the intimacy that existed between Nīlakaṇṭha and his patron and the common interest that bound them together. On the compilation of the *ĀBh. Bhāṣya*, Nīlakaṇṭha observes in one place : यन्मयात्र केषांचित् सूत्राणां तद्युक्तीः प्रतिपाद्य कौषीतकिना श्राढ्येन नारायणाख्येन व्याख्यानं कारितम्, अतस्तदेवात्र लिख्यते । (*TSS* 101, p. 113), Again, at another context, he remarks : इतीदं प्रथमे वयस्येव वर्तमानेन मया द्वितीयवयसि स्थितेन कौषीतकिना श्राढ्येन कारितम् । ·········तस्मिन् स्वर्गते पुनः······व्याख्यानमारब्धम् । (*TSS* 101, p. 156).

It is clear from the above that the credit of enthusing Nīlakaṇṭha in his investigations, and, in fact, to have prompted him to write his *ĀBh.Bhāṣya*, goes to Netranārāyaṇa,[1] the members of whose family are known all through the annals of Kerala history to have been good scholars and, at the same time, patrons of scholarship.

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1. Even with regard to Nīlakaṇṭha's *Tantrasaṅgraha*, its introductory verse,

हे विष्णो निहितं कृत्स्नं जगत् त्वय्येव कारणे ।
ज्योतिषां ज्योतिषे तस्मै नमो नारायणाय ते ॥

has a veiled reference to his patron (Netra)-Nārāyaṇa at whose instance that work too seems to have been written.

5.4. Nīlakaṇṭha's Teachers Ravi and Dāmodara

Nīlakaṇṭha informs us in his *ĀBh.Bhāṣya* that he studied Vedānta under Ravi, *cf. Ravita atta-Vedānta-śāstreṇa,* (*TSS* 101, p. 180). That Ravi was well versed also in *jyotiśśāstra* and that Nīlakaṇṭha imbibed some of his knowledge in astronomy also from Ravi is clear from the introductory verse to Nīlakaṇṭha's *Siddhānta-darpaṇa*, where his teacher has been mentioned by *double entendre* :

श्रीमद्दामोदरं नत्वा भगवन्तं रविं तथा ।
यत्प्रसादान्मया लब्धं ज्योतिश्चरितमुच्यते ॥

A work on astrology, *Ācāradīpikā*, which is a detailed commentary, in verse, on *Muhūrtāṣṭaka*, is ascribed to this Ravi.[1]

The teacher of Nīlakaṇṭha who actually initiated him into the science of astronomy and instructed him on the various principles underlying mathematical calculations was Dāmodara, son of the Kerala-*Dṛggaṇita* author Parameśvara,[2] of the Bhārgava-gotra and resident of the village of Ālattūr (Sanskritised into Aśvattha-grāma) which was situated quite near Nīlakaṇṭha's own village. In his *ĀBh.Bhāṣya*, as also in his other works, Nīlakaṇṭha reverentially refers to his teacher and his studies under him. He speaks of how even as a boy he stayed with his *guru*, at the latter's residence, prosecuting his studies ; *cf.* मया गुरुकुले वसता बाल्य एव etc. (*ĀBh.Bhāṣya, TSS* 110, p. 48). He also refers, often, to his teacher's views and quotes him ; *cf.* प्रकारान्तरेण 'चन्द्रबाहुफलवर्गे'त्यादिना श्रीमद्-दामोदराह्वयादस्मद्-गुरुमुखोद्गतेन श्लोकेनोक्ता तद्युक्ति: etc. (N's *Grahaṇādigrantha*[3] Ts. p 61) ; तच्चोक्तमस्मदाचार्यैः (*ĀBh. Bhāṣya, TSS* 101, p. 47) ; निबद्धं च तत् तदैव अस्मद्गुरुभि: पञ्चभिरुपजातिभि: 'अर्कस्फुटेनानयनं प्रकुर्यात्' etc. (*ibid.*, p. 48) ; तदपि—

"सर्वत्र विष्कम्भदलं श्रुतो वा व्यासार्धके स्याद् विपरीतकर्णः ।"

इत्यस्मद्गुरुणोक्तम् (*Siddhanta-darpaṇa-vyākhya*, on verse 27, edn. p. 30.

Similar quotations and other references, which Nīlakaṇṭha and later authors make, proclaim Dāmodara not only to be a prominent

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1. Ulloor, *Kerala Sāhitya Caritram,* vol. II, Trivandrum, 1954, p. 114. For a Ms. of this work see Kerala Uni. Mss. Lib., No. 3336-B.

2. *Cf.* the detailed colophon quoted above, pp. xxiv.

3. On this work, see below, p. xxxii-xxxiii.

astronomer of the times but also as the author of erudite works on the subject, manuscripts of which, are yet to come to light.

Nīlakaṇṭha followed in the footsteps of Parameśvara, founder of the *Dṛgganita* system of astronomy in Kerala and one of the foremost astronomers of the land. For him Parameśvara was not only the revered father of his *Guru* but was also his *Parama-guru*, by which term he generally refers to him in his works ; *cf.*, यतो भार्गवपरमेश्वराचार्येण अस्मत्परमगुरुणा 'चलांशास्त्वं (4546) इति कल्यब्दे परीक्ष्य पञ्चदशांशपूर्तिनिर्णीता । etc. (*Siddhāntadarpaṇa-vyākhyā*, under verse 18, edn. p. 17); अस्मत्परमगुरुणापि सिद्धान्तदीपिकायाम् एतत् प्रतिपादितम् । *ĀBh.Bhāṣya*, *Golapāda*, verse 3).

5.5. Nīlakaṇṭha's writings

Nīlakaṇṭha has written several works which reflect his deep study of and ripe scholarship in astronomy, embodying the results of his investigations in the subject and interpreting the science lucidly. A mention of his works may, advantageously, be made here :

1. *Golasāra* ('Quintessence of spherical astronomy'), in three *paricchedas*, embodying the basic astronomical elements and procedures.[1]

2. *Siddhāntadarpaṇa* ('Mirror of the laws of Astronomy'), a short work in thirty-two *anuṣṭubhs*, enunciating the astronomical constants with reference to the *Kalpa* and specifying his views on the astronomical concepts and topics.[2]

3. *Candracchāyāgaṇita*, ('Computations concerning the Moon's shadow') or merely *Chāyāgaṇita*, under which title it is sometimes cited, a short work in thirty-two verses on the methods for the calculation of

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1. Cr. edn. with Translation, by K.V. Sarma, V.V.R. Institute, Hoshiarpur, 1970.

2. Critically ed. with the author's own commentary, Translation and Appendices, by K.V. Sarma, Hoshiarpur, 1976, (*Panjab Uni. Indological Series*, No. 7).

time from the measurement of the shadow of the gnomon cast by the Moon and vice-versa.[1]

4. *Tantrasaṅgraha*, being the text edited here, divided into eight chapters comprising 432 verses. This a major work of Nīlakaṇṭha and is an erudite treatise on astronomy. As a work belonging to the *Tantra* class, it takes the commencement of the *Yuga* as the starting point for calculations.

5. *Āryabhaṭīya-Bhāṣya*,[2] an elaborate commentary on the cryptic and *sūtra*-like text of Āryabhaṭa which comprehends in 121 *āryās* the fields of Mathematics and Astronomy. A perusal of the commentary will amply prove that it is no false claim that Nīlakaṇṭha makes when he designates his work as a *'mahābhāṣya'* and explains the method of exposition adopted by him : श्रीमदार्यभटाचार्यविरचितसिद्धान्त-व्याख्याने 'महाभाष्ये' उत्तरभागे युक्तिप्रतिपादनपरे त्यक्तान्यथाप्रतिपत्तौ निरस्तदुर्व्याख्याप्रपञ्चे समुद्घाटितगूढार्थे सकलजनपदजातमनुजहिते निदर्शितगोलिपादार्थे सर्वज्योतिषामयनरहस्यार्थनिदर्शके समुदाहृत-माधवादि-गणितज्ञाचार्यकृत-युक्तिसमुदाये निरस्ताखिलविप्रतिपत्तिप्रपञ्च-समुपजनितसर्व-ज्योतिषामयनविदमलहृदयसरसिजविकासे निर्मले गम्भीरे अन्यूनातिरिक्ते गणितपादगतार्या-त्रयस्त्रिंशद्व्याख्यानं समाप्तम् । (*TSS* 101, p. 180).

In another context, recalling how he came to write the commentary, Nīlakaṇṭha remarks : मयाद्य प्रवयसा ज्ञाता युक्तीः प्रतिपादयितुं भास्करादिभिरन्यथाव्याख्यातानां कर्माण्यपि प्रतिपादयितुं यथाकथंचिदेव व्याख्यानमारब्धम् । (*TSS* 101, p. 156).

The lucid manner in which the difficult conceptions about the celestial globe and astronomical calculations are made clear, the wealth of quotations, and the results of personal investigations and comparative studies presented herein amply justify the appellation *'Mahābhāṣya'* which Nīlakaṇṭha has given to his work.

Nīlakaṇṭha has commented only on the *Gaṇita*, *Kālakriyā* and *Gola-pādas* of the *Āryabhaṭīya*, leaving out the *Gītikāpāda*, which he says is covered by the commentary on the other three sections : *cf.* तद्वेयं

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1. Critically ed. with auto-commentary, Translation and Appendices, by K.V. Sarma, Hoshiarpur, 1976, (*Panjab Univ. Indological Series*, No. 6).

2. Ed. in *TSS* 101, 110, 185, (1930, 1931, 1957).

त्रिपाद्यस्माभिर्व्याख्यासिता, यतस्तद्व्याख्येयरूपत्वात् गीतिकापादस्य । एतद्व्याख्यानेनैवार्थः प्रकाशेत । (*TSS* 101, p. 1).

6. *Siddhāntadarpaṇa-vyākhyā*, a commentary on his own *Siddhāntadarpaṇa*, included in the edition of the text, (see above, p. xxix fn. 2). The commentary is elaborate and resembles, in diction and treatment, his *Āryabhaṭīya-Bhāṣya*. It is in this work that Nīlakaṇṭha gives the actual date of his birth as Kali 4545 : A.D. 1444.

7. A commentary on the *Candracchāyāgaṇita*, added to the edition of the text (see pp. xxix-xxx and fn.).

8. *Grahaṇanirṇaya*, a work on the computation of lunar and solar eclipses. Manuscripts of this work are yet to be discovered, but later authors and Nīlakaṇṭha himself in his *ĀBh.Bhāṣya* quote from this work ; *cf.* तथैव ग्रहणमध्यं च । स्फुटसाम्ये तु विक्षेपकोटिमण्डलापक्रममण्डलयोः भुक्तभागसाम्यमेव स्यात् । तदुक्तं मया ग्रहणनिर्णये –

परमक्षेपकोटिघ्नः पातोनार्कभुजागुणः ।
स्वेष्टविक्षेपकोट्याप्तस्तत्क्षेपकृतियोगतः ॥
पदं यच्चापितं यच्च पातोनार्कभुजाधनुः ।
तद्विशेषं हतं षष्ट्या गत्यन्तरहृतं क्षिपेत् ॥
पर्वान्ते युग्मपदे क्षेपे शोधयेद् विषमे पदे ।
एवंकृतोऽपि पर्वान्तः सूर्येन्द्वोर्ग्रहणे स्फुटम् ॥

(*TSS* 185, p. 102)

These verses are quoted also by Śaṅkara in his commentary on Nīlakaṇṭha's *Tantrasaṅgraha* (on ch. IV, verse 27, *TSS* 188, p. 107) with the introductory remark : तदुक्तमनेनैव ग्रहणनिर्णये ।

9. *Sundararāja-praśnottara*. Sundararāja, son of Anantanārāyaṇa, was an astronomer of the Tamil country contemporaneous with Nīlakaṇṭha and author of a detailed commentary on the *Vākyakaraṇa* or *Vākyapañcādhyāyī* which is a manual on the basis of which almanacs are computed in the Tamil districts.[1] Sundararāja had the greatest respect for Nīlakaṇṭha whom he addressed for clarification of certain

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1. Cr. ed. by T.S. Kuppanna Sastri and K. V. Sarma, K. S. Research Inst., Madras, 1962.

points in astronomy. Nīlakaṇṭha's detailed answers to these questions formed a regular work, *Sundararāja-praśnottara*. Manuscripts of this work are yet to come to light, but both authors refer to this work. Sundararāja in his commentary on the last verse of ch. V of the *Vākyakaraṇa* says :[1]

अत्र तु गतियोगांशकेनैव हरणं युक्तमिति श्रीमत्-केरलसद्ग्रामनिवासि-नीलकण्ठार्येण त्रिस्कन्धविद्यापारदृश्वना षड्दर्शनीपारंगतेन आश्वलायनसूत्रेण गर्गगोत्रेण नवकलव-(?)जातेन गोलचूडामणिना अस्मदनुग्रहार्थं सुन्दरराजप्रश्नोत्तराख्ये ग्रन्थे प्रतिपादितम् । तेन गतियोगेनैव विभज्य स्थितिदलं ज्ञेयम् ।

Nīlakaṇṭha too refers to work in his *ĀBh.Bhāṣya, Gola.*, 48 : *cf.* सुन्दरराजप्रश्नोत्तराख्ये मयोक्तमवाप्यनुसन्धेयम् । (*TSS* 185, p. 149).

10. A *Grahaṇādi-grantha,* copied in continuation of Nīlakaṇṭha's *Siddhanta-darpaṇa-vyākhya* in the Trivandrum Palace manuscript No. 975. The work as available in this manuscript begins '**अथ ग्रहणम्**' and without any more introduction, continues : **नन्वेवमपि स्वकाल एव गीतिकोक्तभगणाद्या: । गीतस्य ग्रहणस्य [च] प्रत्यक्षसंवाद: स्यात् ।** It is goes on to describe the necessity of correcting old astronomical constants by observation, deals in detail with the *Śakābda-saṁskāra*, quotes the verses of N's *Parama-guru* Parameśvara from his *Siddhāntadīpikā* (*Mahābhāskarīya-bhāṣya-vyākhyā*),[2] on the latter's observation of some eclipses and after some more discussion ends abruptly. There is no doubt that this work is from Nīlakaṇṭha's pen. References herein to his own works, teacher etc. fully confirm this point. One of his own works is referred to herein thus : **अत एव मया छायागणिते तत्साधनतया दृक्क्षेपानयनमुक्तम्**—'**अन्त्यद्युज्या**' etc. (p. 60 of my transcript). The verses quoted are from Nīlakaṇṭha's *Candracchāyāgaṇita*, vv. 9-10. He refers to his grand-teacher Parameśvara and his own *ĀBh.Bhāṣya* too, herein : *cf.*, **तस्मात् सिद्धान्तदीपिकोदाहृतानि ग्रहणान्यस्माभिर्दृष्टानि च तत्तदवसरे वक्ष्यमाणानि परमेश्वरोक्तप्रकारेण अर्कविमध्यमगमीय श्रीपत्युक्तप्रकारेण स्फुटीकृत्य कालक्रिया-गोलपादोक्ताभिरस्माभिर्व्याख्याताभि: युक्तिभिरिसद्धै: क्रियाविशेषैश्च गण्यन्ताम् ॥** (pp. 57-58 of my transcript). The *ĀBh.Bhāṣya* also is referred to elsewhere in this work (*cf.* pp. 62, 63 of the transcript). For a characteristic reference to N's teacher, see :

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1. *Ibid.*, p. 119.

2. Cr. Ed., by T.S. Kuppanna Sastri, *Madras Govt. Or. Ser.*, 130 (1957).

प्रकारान्तरेण 'चन्द्रबाहुफलवर्गेत्याविना श्रीमद्-दामोदराह्वयास्मद्गुरुमुखोद्गतेन श्लोकेनोक्ता, तद्युक्तिरपि आर्यभटीयान्तर्भूतैव । (p. 61 of the transcript).

11. *Grahaparīkṣākrama* (?). The well-known Kerala astrologer, the late Puliyūr Purushottaman Nampūtiri, has edited[1] an old, incomplete[2] Malayalam summary of a Sanskrit work under the title *Grahaparīkṣākrama*. The textual verses were not available to the editor and he presumed that the author was Dṛggaṇita-Parameśvara.[3] These verses are, actually to be found in Nīlakaṇṭha's *Bhāṣya* on the *Golapāda* of the *Āryabhaṭīya*, under verse 48 (*TSS* 185, pp. 132-49). It is a long tract of about 200 verses, enunciating the principles and methods for verifying astronomical computation by regular observations. The work ends thus :

इति संक्षेपतः प्रोक्ता परीक्षा ज्योतिषामिह ।
कालमानचतुष्कस्य श्रुतस्य विवृतिस्त्वियम् ॥

It is not however very definite whether this is an independent work with the title *Grahaparīkṣākrama* and is quoted in extenso in the *Bhāṣya* or whether it is but a part of the *Bhāṣya*.

Nīlakaṇṭha should have written more works than those mentioned above since there are quotations attributed to him in later works, for instance, in Śaṅkara's commentary *Laghuvivṛti* on Nīlakaṇṭha's *Tantrasaṅgraha*, which could not be traced to his known works. Again, the Trivandrum Palace Ms. No. 975, containing Nīlakaṇṭha's *Sidahānta-darpaṇa-vyākhya* and the work on eclipses etc. described above, has, in continuation, some incomplete tracts with no definite titles, which again, to all appearance, seem to be Nīlakaṇṭha's writings.

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1. Pub. by the Astrological Research Institute, Bombay-25, 1950.

2. The colophonic words at the end of the edition indicating its completion form only the editor's addition and not found in the manuscript.

3. *Vide* the editor's Introduction, p. i ; see also Shri Nampūtiri's review and opinion on *Gaṇitaprakāśika* by K. V. A. Rama Poduval, Canannore, 1950, p. xiv.

According to some, Nīlakaṇṭha has composed a work entitled *Grahanirṇaya*.[1] It is likely, however, that this is only the *Grahaṇa-nirṇaya*, noticed above. Ulloor attributes to Nīlakaṇṭha a work called *Gaṇitayukti*. Thus, speaking about a *Bhāṣāyuktibhāṣā*, he says that "it is not the work of Keḷallūr Comātiri, author of *Gaṇitayukti*."[2] The ascription is wrong and the fact is that while our author belonged to the Garga-gotra, this latter work is by an anonymous author belonging to the Bhāradvāja-gotra as is clear from its first verse, which runs as follows :[3]

विविदत्वार्यभटप्रोक्तगोलतत्त्वेन केनचित् ।
भारद्वाजेन तन्यन्ते काश्चित् गणितयुक्तय: ।।

5.6. Chronology of Nīlakaṇṭha's works

It has been noticed[4] that Nīlakaṇṭha's *ĀBh.Bhāṣya* is later than his *Tantrasaṅgraha* and *Golasāra* which are quoted in the former. But nothing has been said about the chronology of his other works. The present writer's investigations have, however, shed some light on this matter.

The first five works enumerated above, *viz.*, *Golasāra*, *Siddhānta-darpaṇa*, *Candracchāyāgaṇita*, the commentary thereon, and *Tantra-saṅgraha* do not refer to any other work, but are, in their turn, quoted in other works of Nīlakaṇṭha. Of these, the *Tantrasaṅgraha* is the most comprehensive of the five and gives the date of its composition as 1500 A.D., *i.e.*, it was written when the author was aged fifty-six. On the above considerations it may be presumed that the other four works were written before this date. The *Grahaṇanirṇaya* and the *Sundararāja-praśnottara*, of which manuscripts have yet to be discovered and which are quoted in the *ĀBh.Bhāṣya*, have also to be ascribed to about this period. This *Bhāṣya*,

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1. Vaṭakkumkūr Rajaraja Varma, *Hist. of Skt. Lit. in Kerala*, vol. I, p. 389 ; Ulloor, *Kerala Sāhitya Charitram*, vol. II, p. 117.

2. Uloor, *ibid.*, p. 122.

3. Ms. : Madras, Mal. D. 339, p. 83-89, now, transferred to the Kerala Univ. Or. Res. Inst. and Mss. Library, Trivandrum.

4. Ulloor, *Kerala Sāhitya Charitram*, vol. II, p. 119.

a mature work, Nīlakaṇṭha wrote when he was very old, as he himself remarks : मयाद्य प्रवयसा ··यथाकथंचिदेव व्याख्यानमारब्धम् (*TSS* 101, p. 156). The *Siddhānta-darpaṇa-vyākhyā* which refers to the *Āryabhaṭīya-Bhāṣya*, (*Cf.* com. on verse 25 : एतत्सर्वं मया आर्यभटीयव्याख्याने प्रपञ्चितमिति विरम्यते । see p. 24, of the edn.) is still later. And, so also his discursive treatise on eclipses which too refers to the *ĀBh. Bhāṣya* more than once ; *cf.* तत्र कालक्रियापादे सूचितं मया विवृतम् । (p. 63 of my transcript) ; एतत्सर्वं गणितपादे विस्तरेणोपपादितः । (*ibid.*, 63).

5.7. Date of Nīlakaṇṭha

Indisputable evidences are available for fixing the date of our author. Śaṅkara, Nīlakaṇṭha's pupil, in his commentary on his teacher's *Tantrasaṅgraha*, points out that the first and last verses of that work contain chronograms specifying the dates of the commencement and of the completion of the work. Thus, after giving the literal meaning of the first verse of the work :

'हे विष्णो निहितं कृत्स्नं' जगत् त्वय्येव कारणे ।
ज्योतिषां ज्योतिषे तस्मै नमो नारायणाय ते ॥

Śaṅkara says : आचार्येण इमं श्लोकं आदितो ब्रुवता प्रथमपादेन प्रबन्धारम्भदिन-कल्यहर्गणश्च अक्षरसंख्यया उपदिष्टः । समाप्तिसमयाहर्गणश्च 'लक्ष्मीशनिहितध्यान' इत्यन्ते भविष्यति ।

These two Kali dates, 16,80,548, and 16,80,553, work out to Kali Year 4601, Mīna 26, and 4602, Meṣa 1, both dates occurring in 1500.

The *Siddhānta-darpaṇa* and Nīlakaṇṭha's own commentary thereon give, respectively, the year and actual date of his birth. *Cf.* :

Text. : कलिसन्ध्यष्टमांशे स्वशतांशाढ्ये गते ततः ।
धनुर्मिथुनयोर्मध्ये प्रायशस्त्वयने उभे ॥
(*Sid. dar.*, 18)

Com. : विंश्याब्दशतमिता खलु काले सन्ध्या स्मर्यते । तस्य अष्टमांशः सार्धविंश्याब्दद्वादशकः । स च सौराब्दानां पञ्चचत्वारिंशत्-शतमितः (4500) । तस्य शतांशः पञ्चचत्वारिंशदब्दः (45) । ततः स्वशतांशाढ्यः 'शिवशिवे'ति (4545) कल्यब्दैस्तावति याते उभे अयने उत्तरदक्षिणाख्ये प्रायशो धनुर्मिथुनमध्ये स्तः । तदा अयनचलनांशाः धनात्मकाः पञ्चदशसंख्या बभूवुः । प्रायिकत्वं च कलाष्टकाधिकत्वात् । यतो

भार्गव-परमेश्वराचार्येण अस्मत्परमगुरुणा 'बलांशास्त्वं' (4536) इति कल्यब्दे परीक्ष्य पञ्चवशांशपूर्तिर्निर्णीता । अतः सन्ध्याष्टमांशशतांशस्य प्रायिकत्वम् । स्वजन्मकालज्ञापनार्थं चैवमुक्तम् । तदा अहर्गणश्च 'त्यजाम्यज्ञतां तर्कैः' (16,60,181) इति । (p. 17, of the edn). Here, Nīlakaṇṭha himself says that he was born on the Kali day 16,60,181, which works out to A.D. 1444, June 14.

That Nīlakaṇṭha lived to a ripe old age, even to become a centenarian, is attested by a contemporary reference made of him in a Malayalam work on astrology, *viz*., the *Praśnasāra* by Mādhava, a Nampūtiri brāhmin of the Īñcakkāzhvā house in Kerala, who wrote his work in A.D. 1542-43. Here, Mādhava says that he could count upon reputed authorities like 'Keḷanallūr' to recommend his work. *Cf.* :

> āḷ-āyat-ādaravil ādiyil Attimaṯṯam
> lōkōttaran punar-itinn-iha '*Keḷanallūr*' /
> ābhāsar allaṟivatuḷḷavar ādarippān
> porum prasiddhi perikoḷḷavar uṇṭanekam //

The date of composition of this work, *Praśnasāra*, is given as Kollam era 718/Kali 4644 (A.D. 1543) by the following verse in the work itself :

> ezhunūṯṯorupatteṭṭāvatu Kollam atāya nāḷ /
> varunna viṣuvad, *bhāvatattvam* (4644) kalyabdam āyatu //

Rightly does Nīlakaṇṭha remark in his *Ā.Bhāṣya* : मयाद्य प्रवयसा ··· ··· यथाकथंचिदेव व्याख्यानमारब्धम् (*TSS* 101, p. 156). Moreover, we know of at least two more works composed by him subsequent to his writing the *ĀBh.Bhāṣya*, *viz.*, the commentary on the *Siddhānta-darpaṇa* and the work on eclipses etc., both of which quote the *ĀBh.Bhāṣya*.

5.8. Versatility of Nīlakaṇṭha

For a mere Jyautiṣika and one who had specialised only on its astronomical aspect, Nīlakaṇṭha seems to be very well read. Every other page of his writings substantiate his knowledge of the several branches of Indian philosophy and culture. Sundararāja, the Tamil astronomer, calls him *ṣaḍ-darśanī-pāraṅgata*, 'one who had mastered the six systems of philosophy'.[1] Nīlakaṇṭha himself informs us that he studied Vedānta under Ravi : *cf.*, *Ravita ātta-Vedāntaśāstreṇa*. He can

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1. *Cf.* his commentary on the *Vākyakaraṇa.*, 5.19, (edn., p. 119).

refer to a Mīmāṁsā authority to establish a mathematical point[1] and with equal felicity apply a grammatical dictum to the same purpose.[2] Piṅgala's *Chandas-sūtra*[3] and the lexicons are quoted as the occasion demanded. The scriptures and the Dharmaśāstras also come in for citation.[4] And, so also the Purāṇas[5] like the *Bhāgavata*[6] and the *Viṣṇu*.[7]

As for Jyotiṣa works, Nīlakaṇṭha exhibits a surprising familiarity with a large number of them, from the *Vedāṅga-Jyotiṣa* down to the treatises of his own times. He uses all types of jyotiṣa texts, *Gaṇita*, *Saṁhitā* and *Horā*, but as became his subject of specialisation, his quotations are mainly from texts dealing with astronomy proper. Some of the more important texts of all-India prevalence that Nīlakaṇṭha quotes are : *Vedāṅga-Jyotiṣa*, *Āryabhaṭīya*, Varāhamihira's *Pañcasiddhāntikā*, *Bṛhajjātaka* and *Bṛhatsaṁhitā*, the *Sūryasiddhānta*, Śrīpati's *Siddāntaśekhara* and Muñjāla's *Laghumānasa*. Of texts popular only in Kerala may be mentioned the *Parahitagaṇita* or *Grahacāranibandhana* of Haridatta, the *Bhāṣya* by Bhāskara I on the *Āryabhaṭīya* and his *Laghu* and *Mahābhāskarīyas*, Govindasvāmī's *Bhāṣya* on the latter and Parameśvara's super-commentary thereon. Other works of Parameśvara

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1. *Cf.*, *ĀBh.Bhāṣya*, *TSS* 101, pp. 54, 158, where Pārthasārathi Miśra's *Vyāptinirṇaya* and *Advaitavivaraṇa* and *Ajitā* (com. on *Ślokavārttika*) and its commentary *Vijayā* come in for quotation. On *Golapāda*, 50, the *Bṛhaṭṭīkā* of Kumārila Bhaṭṭa is cited.

2. *Cf.*, quotations from the *Vākyapadīya*, *ĀBh.Bhāṣya*, *TSS* 110, p. 31.

3. See *ĀBh.Bhāṣya*, *TSS* 101, p. 4.

4. See com. on *Siddhānta-darpaṇa*, verses, 1, 2 ; the Grahaṇa work, pp. 48, 49 ; and *Āryabhaṭīya-bhāṣya*, *Golapāda*, verse 48, where the *Taittirīya-Āraṇyaka*, *Ṛgveda*, *Parāśarasmṛti*, *Kālanirṇaya* of Sāyaṇa, *Manusmṛti* etc. are quoted.

5. See *Siddhānta-darpaṇa-vyākhyā*, p. 1.

6. *Cf.*, *ĀBh.Bhāṣya*, *TSS* 110, pp. 16, 26.

7. *Cf.*, *ibid.*, p. 8.

like his *Āryabhaṭīya-vyākhyā* also come in for citation as also passages from his own teacher Dāmodara. Another Kerala author whom Nīlakaṇṭha quotes often is Mādhava, often styled 'Golavid', who was a reputed astronomer of the times.[1] Manuscripts of several works quoted by Nīlakaṇṭha are yet to be unearthed and a detailed study of the numerous authorities quoted by Nīlakaṇṭha is bound to throw welcome light on the annals of Hindu astronomy.

6. INDENTIFICATION OF THE TS COM. IN VERSE

6.1. Details in the TS Com.

In contrast to Nīlakaṇṭha who supplies ample biographical details about himself, his commentator is highly reticent in the matter. All that the *TS Com.* has, in this connection, is confined to two verses, which are more of a general than of a specific nature. These verses are :

यत् तन्त्रसंग्रहं नाम पूर्वैः प्रकरणं कृतम् ।
हितायाल्पधियां तस्य पद्यैर्व्याख्या विलिख्यते ॥

(Com. verse, I. 3, p. 1)

'The treatise named *Tantrasaṅgraha* which was composed by the (respected) elder savant (*pūrvaiḥ*)—of that a commentary in verse is being written (by me) for the benefit of the slow-witted.'

इत्येष परक्रोडावासद्विजवरसमीरितो योऽर्थः ।
स तु तन्त्रसंग्रहस्य प्रथमेऽध्याये मया कथितः ॥

(Com. verse, I. 821, p. 77)

'Thus have I set out in (the commentary to) the First chapter of the *Tantrasaṅgraha*, the exposition that has been well stated (elsewhere) by the revered brāhmin of the Parakroḍa house.'

The second verse is repeated at the end of the commentary on chs. II, III and IV just with the change of the number of the respective chapters.

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1. On this Mādhava, (*c.* 1340-1425), who was a teacher of Parameśvara, see the present writer's Introduction to his edition of Mādhava's *Veṇvāroha*, (Trippunithura, Cochin, 1957), and *Sphuṭacandrāpti*, (Hoshiarpur, 1973).

6.2. Incorrect inferences

The said all-too-brief statements, coupled with the fact that the commentary is incomplete, have induced scholars to draw different inferences therefrom. While all scholars are unanimous about the anonymity of the commentary, some maintain it to be a work *by a nampūtiri brāhmin of the Parakroḍa* (Tṛ-p-Paraṅṅoṭṭu) *village* in Central Kerala.[1] This is clearly an incorrect interpretation of the passage *Parakroḍāvāsadvijavara-"samīrito yo'rthaḥ" sa mayā kathitaḥ*.

Equally unwarranted is the statement in the *New Catalogus Catalogorum* (Madras University) to the effect that the author of the commentary was "a brahmin of Parakroḍa family, student of Jyeṣṭhadeva" (vol. VIII, p. 97). Actually, it is the teacher Jyeṣṭhadeva who is the "brahmin of the Parakroḍa family" and not the student, about whom nothing is mentioned in the verse.

Construing the passage more plausibly, others identify the author as a disciple of the *Parakroḍāvāsa-dvijavara* and hold that he was setting out in the commentary the *Tantrasaṅgraha* as was taught to him by his teacher.[2] It has to be noted, however, that the teacher-disciple relationship is no more than an inference and what is actually, referred to is only the 'well-stated exposition' (*samīrito yo'rthaḥ*) of the Parakroḍa brāhmin, which, it will be shown below, is the Malayalam work *Yuktibhāṣā* (see § 6.4, pp. xliv-v).

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1. *Cf.* : Ulloor S. Parameswara Aiyar, *Kerala Sāhitya Charitram*, vol. II, (Kerala University, Trivandrum, 1954), p. 120 ; Vaṭakkumkūr Rajaraja Varma, *Keralīya Saṁskṛta Sāhitya Charitram*, vol. II, (Mangalodayam, Trichur, 1947), p. 498. This view is followed by Suranad Kunjan Pillai, *TSS* edn. of *Tantrasaṅgraha*, Introduction, p. ii ; E. Eswaran Nampoothiri, *Sanskrit literature of Kerala*, (Trivandrum, 1972), p. 156 ; and S. Venkitasubramonia Iyer, *Kerala Sanskrit literature : A bibliography*, (Kerala University, Trivandrum, 1976), p. 246.

2. See K.K. Raja, 'One of the commentators of *Tantrasaṅgraha* seems to have been a disciple of Jyeṣṭhadeva; for he says that he learnt the ideas of the text with the help of a Brahmin of Parakroḍa. Parakroḍa can be the Sanskritized form of Paraṅṅoṭṭu, which is the family name of Jyeṣṭhadeva." 'Astronomy and mathematics in Kerala', *Adyar Library Bulletin*, 27 (1963) 158. See also K.V. Sarma, *A history of the Kerala school of Hindu astronomy*, (Hoshiarpur, 1972), pp. 60-61.

A more serious misconception is about the extent of the *Tantrasangraha*. In the edition of *Yuktibhāṣā*, mentioned above, the editors, *viz.* the late Rama Varma Maru Thampuran and A.R. Akhileswara Iyer have, in their Notes added to that edition, cited verses from the *TS* and the verse commentary of *TS* giving the *common subscription Tantrasangraha*, to both, without distinguishing between the two and without giving any reference to the chapter and verse numbers of these citations.[1]

The source of this non-distinction is, in fact, to be traced to the "*Tantrasangraha-vyākhyā*—A transcript in the keeping of Rama Varma (Maru) Thampuran of a manuscript in the Deśamangalattu Mana"[2] (apparently a sister-transcript prepared from the Deśamangalam palm-leaf original of the Madras transcript, No. R. 2505, used as Ms. A in the present edition), for, the said transcript was made use of by the editors of *Yuktibhāṣā* for writing their Notes in which they have quoted the commentarial verses without distinguishing these verses from the textual verses of the *TS*. This undifferentiated citation has made later scholars to consider the commentarial verses quoted in this manner as genuine textual verses. Since these verses were not to be found in the available text of the *TS*, they commenced to hazard even the possibility of a longer version of the *TS* which they thought might have contained those verses. Thus, T.A. Saraswati observes that "the *Tantrasangraha*, published by the Trivandrum University (*sic*) seems to contain one part only of the Text. The editors of the *Yuktibhāṣā* had access to the complete Ms.'"[3]

The encrustation, over the years, of the feeling of such a possibility, coupled with the anonymity of the *TS Com.* and the imper-

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1. Pub. : Mangalodayam Press, Trichur, 1948. For such undistinguished citations, see pp. 113-14, 121, 134, 178, 190, 200, 203, 206, 208, 219.

2. This transcript was later borrowed by T.A. Saraswati from Maru Thampuran and used in the preparation of her Ph.D. dissertation entitled *Geometry in ancient and medieval India*, (Madras University, 1964), and has been referred to by her in the 'Bibliography' to her said dissertation.

3. T.A. Saraswati, 'The development of mathematical series in India,' *Bull. of the National Inst. of Science*, (New Delhi), No. 21 (1962), p. 334, fn. 9.

fect interpretations to its colophonic verse, has resulted in the picturing of the textual situation of *TS* to be amorphous and highly unsettled. It has even been doubted whether the *TS Commentary* is a commentary on the *TS*, at all.

The latest statement in the matter comes from T.S. Rajagopal and M.S. Rangachari who present all these points in a combined form. They observe : "*Tantrasaṅgraha-vyākhyā*, by its very name, proclaims itself a commentary on *Tantrasaṅgraha*, a classic composed in A.D. 1500 by the versatile savant Nīlakaṇṭha. However, some extant manuscripts of the latter work, notably those taken into account in preparing the printed edition of the work in the *Trivandrum Sanskrit Series*, lack the Sanskrit texts corresponding to the mathematical results given above in modern notation. The question thus arises as to whether there could have been a larger version of *Tantrasaṅgraha* containing these results, orally handed down in traditional fashion by successive teachers, to their pupils. A positive answer to this question seems to be warranted by two considerations : (i) *Yuktibhāṣā* by Jyeṣṭhadeva (A.D. 1500-1610), a younger contemporary of Nīlakaṇṭha, claims to expound the mathematical principles of *Tantrasaṅgraha* ... (ii) *Tantrasaṅgraha-vyākhyā*, though an anonymous work, claims, at the end of every chapter, to have derived the material of that chapter from the teachings of a Brahmin of Parakroḍa, now identified with Jyeṣṭhadeva, this material aiming at an elucidation of portions of *Tantrasaṅgraha*, since otherwise the work would not be a *vyākhyā* in the sense intended."[1]

Here is an anomalous situation which needs to be properly probed and the doubts cleared, if possible, once for all. With this objective in view, available data has been analysed and new information presented below, through which it is hoped to settle satisfactorily the problem of the text of the *Tantrasaṅgraha*, the *TS Com.* being a commentary on the *TS*, the source of the *TS Com.* and its purpose, identification of the author of the *TS Com.*, his date and works and allied matters.

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1. T.S. Rajagopal and M.S. Rangachari, 'On an untapped source of medieval Keralite mathematics,' *Souvenir of the 42nd Annual Conference of Indian Mathematical Society*, Trivandrum, Dec. 1976, being the condensation of a detailed paper on the subject to be published in *Archive for History of Exact Sciences*, (West Germany).

6.3. The extent of Tantrasaṅgraha

The extent of the *TS* is suggested as a problem just on account of the non-distinguished citation of some verses of the *TS* and *TS Com.* in the modern Notes added to the edition of *Yuktibhāṣā* and not because of the said *TS Com.* verses being found in *TS* mss. or quoted as *TS* verses in early works. While this fact should by itself, indicate the fallibility of the suggestion, this occasion might, all the same, be taken advantage of to probe into the text tradition of *TS* and to show that in the astronomical tradition of Kerala, the *TS* is known only in its presently available form and in no other form.

i. *Manuscripts of Tantrasaṅgraha*

The *Tāntrasaṅgraha* as edited in the present publication as also in the *Trivandrum Sanskrit Series* is divided into eight chapters, and contains 432 verses in all. Since the work had been popular and was accepted as an authority, a large number of manuscripts of the work exists, of which about fifty have been documented in the *New Catalogus Catalogorum*, (Madras University, vol. VIII, 1974, p. 97). One of these manuscripts, No. 475-E of the Kerala Univ. Or. Res. Inst. and Mss. Library, gives the date of its transcription through the chronogram *sevyo dugdhābdhitalpaḥ*, being Kali day 16,99,847, falling in the year A.D. 1551, and so this Ms. is almost contemporaneous with its author Nīlakaṇṭha Somayāji who passed away in about A.D. 1545. All the said documented manuscripts conform to the division and extent of the work as mentioned above. In several cases there are post-colophonic statements expressing the completeness of the work in eight chapters. In one such manuscript, dated M.E. 928 (A.D. 1753), being Ms. No. C. 224-C, deposited in the said Library, the total number of verses in the work is also stated to be 432, which conforms to the presently available text.

Cf. : इति तन्त्रसंग्रहे अष्टमोऽध्यायः । तन्त्रसंग्रहः समाप्तः । अध्यायं एट्टिलुं कूटि श्लोकङ्ङळ् नानूट्टिमुप्पत्तिरण्टु । ९२८-ामाण्ट चिङ्ङमासतिल् एषुत्तिच्च पुस्तकम् ॥

ii. *Quotations from Tantrasaṅgraha*

Tantrasaṅgraha having been held as an authority, its verses come in for citation in later texts. Among works in which such citations occur are the *Laghuvivṛti-s* of Śaṅkara on the *TS* (edn.: *TSS* 188) and on *Pañcabodha* IV (Ms. : Ker. Uni. Mss. Lib., No. 411-A), the Malayalam Com. on Śaṅkara's *Karaṇasāra* (Ms. Kerala Uni., No. C. 173-A), the

Yuktibhāṣā, and Nīlakaṇṭha's own *Bhāṣya* on the *Āryabhaṭīya*, which was written by him subsequent to his *Tantrasaṅgraha*. All the *TS* citations herein are found in the present text of *TS*. It is also noteworthy that none of the nine sets of verses cited by T.S. Rajagopal and M.S. Rangachari occur herein as quotations from the *TS*.

iii. *Evidence of expository texts*

Several commentaries on the *Tantrasaṅgraha* are known, including the *Laghuvivṛti*, the *TS Com.* and two Malayalam commentaries represented by Mss. Nos. 697 (=T. 1251), L. 1343, 8358-E, 12663, 12674 and T. 211-C of the Kerala Univ. Mss. Library. All these commentaries conform to the available text of the *TS*. Moreover, the post-colophonic statements in some of these manuscripts indicate also the ending of the work with the eighth chapter.[1]

iv. *Indication in the TS itself of its beginning and end*

The completeness of the *TS* in its present form is indicated in the text itself. Nīlakaṇṭha commences the work, as mentioned earlier, with a formal invocation to his favourite deity God Viṣṇu :

हे विष्णो निहितं कृत्स्नं जगत् त्वय्येव कारणे ।
ज्योतिषां ज्योतिषे तस्मै नमो नारायणाय ते ॥ १.१ ॥

The author ends the work with the benediction by the same diety :

गोलः कालः क्रिया चेति द्योत्यतेऽत्र मया स्फुटम् ।
लक्ष्मीशनिहितध्यानैरिष्टं सर्वं हि लभ्यते ॥ ८. ३९-४० ॥

Not only this. *Laghuvivṛti*, the commentary on *TS*, by a pupil of the author himself, specifies that the phrases *he viṣṇo nihitaṁ kṛtsnam* and *lakṣmīśanihitadhyānaiḥ*, occurring, respectively, in the first and last lines of the work, signify in *akṣara-saṅkhyā* the dates of the commencement and completion of the *TS* by Nīlakaṇṭha, *viz.*, Kali days 16,80,548 and 16,80,553, both falling in A.D. 1500. Thus, after explaining the literal sense of the first verse, he adds :

1. See, in this connection, the post-colophonic statements *samāptaḥ granthaś cāyam* and *samāptaṁ cedam* at the end of the manuscripts of *Laghuvivṛti* used for the present edition (see below, p. 343).

आचार्येण इमं श्लोकम् आदितो ब्रुवता प्रथमपादेन (*i.e.*, by हे विष्णो निहितं कृत्स्नं) प्रबन्धारम्भदिनकल्यहर्गणश्च अक्षरसंख्यया उपदिष्टः । समाप्तिदिनाहर्गणश्च 'लक्ष्मीशनिहितध्यानैः'' इत्यन्ते भविष्यति । (*TSS* edn., p. 2).

Had there been any Second Part to the *TS* or any expanded version of the work, the author's own disciple could be expected to know the same and make at least a mention thereof in his commentary composed in A.D. 1556, a few years after the demise of the author.

Under the circumstances set out above, it is impossible even to visualise the possibility of "a larger version of *Tantrasaṅgraha* ... orally handed down in traditional fashion by successive teachers to their pupils," as proposed by Rajagopal and Rangachari, or to state that "the *Tantrasaṅgraha* published by the Trivandrum University seems to contain one part only of the Text," as stated by T.A. Saraswati.

6.4. Yuktibhāṣā, TS and TS Com.

In order to appreciate the real aim of the author of the *TS Com.*, it is necessary to understand the exact relationship which it bears to the Malayalam work *Yuktibhāṣā* '(Mathematical) Rationale (explained in the Malayalam) language', and also the purpose for which the latter work had been composed by Jyeṣṭhadeva (A.D. 1500-1610), a nampūtiri brāhmin of the Parakroḍa family (Paraṅṅoṭṭu nampūtiri in Malayalam).[1] In the work he refers to Nīlakaṇṭha, the author of *Tantrasaṅgraha* and other works, as *Ācārya* (Teacher)[2] and specifies at the beginning of the work his objective in composing it, in the words :

"aviṭe naṭe Tantrasaṅgrahatte anusariccuninnu grahagatiyiṅkal upayogamuḷḷa gaṇitaṅṅaḷe muzhuvane colluvān tuṭaṅṅunneṭattu naṭe

1. Manuscripts of *Yuktibhāṣā*, of which a large number have been known and catalogued under different titles such as *Gaṇitanyāyasaṅgraha*, *Gaṇitayuktibhāṣā*, *Tantranyāyadīdhiti* and *Yuktibhāṣā*, do not mention the name of its author. For his identification from external sources and collection of biographical details, see K.V. Sarma, 'Jyeṣṭhadeva and his identification as the author of *Yuktibhāṣā*', *Adyar Library Bulletin*, 22 (1958) 35-40.

2. *Cf.*, for instance : *iprakāratte uṇṭu collīṭṭu Siddhāntadarpaṇattil Ācāryan* : *"antyadyujyeṣṭabhakrāntyoḥ"* etc. (*Siddhāntadarpaṇa*, verse 28 *b*. (Section on Apamadyujyānirūpaṇa, p. 64 of my press copy),

sāmānyagaṇitaṅṅaḷāyirikkunna saṅkalitādiparikarmaṅṅaḷe-c-collunnū." (Edn., p. 1).

'Now, commencing to expound, in full, the calculations that are useful in computing the planetary movements in accordance with (the enunciations in) the *Tantrasaṅgraha*, (I am) stating first addition and other logistics which form the general mathematical operations.'

It has to be noted here that the *Yuktibhāṣā* does not claim to be a 'commentary' on the *TS*. On the other hand, its aim is to provide the basic equipment needed by one who desires to study the computation of planetary movements as depicted in the *Tantrasaṅgraha*. This purpose it serves by positing the basic concepts and theories of mathematics and astronomy, stating the definitions, and setting out the methodologies and their rationales. Again, the *Yuktibhāṣā* being an independent work with a different objective, it cannot and does not deal with all topics dealt with in the *TS*. While the First Part of *Yuktibhāṣā*, which, as noted earlier, has been edited in an exemplary manner with highly elucidative Notes by Rama Varma Maru Thampuran and Akhileswara Iyer, concerns itself with mathematical preliminaries, it is the Second Part of the work which deals with astronomy proper.[1] Since the arrangement in both the works is according to subjects, there is a common sequence of the main subjects dealt with but not, always, of the topics treated.

The aim of the *TS Com.*, as could be gathered from its way of exposition, seems to be threefold : (1) To present in lucid *Sanskrit* verse the mathematical and astronomical material presented in the *Malayalam* language in the *Yuktibhāṣā*, in pursuance of which a number of prose passages in the *Yuktibhāṣā* have been adapted into Sanskrit verse in the *TS Com.* ;[2] (2) to supplement it with additional material of

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1. A highly imperfect and erratic edition of the entire work (*i.e.*, Pts. I and II), is available under the title *Gaṇita-Yuktibhāṣa* (*Madras Govt. Or. Mss. Series*, No. 32, Madras, 1953). In view of the importance of Part II of the work, a critical edition thereof with Notes is under preparation by the present editor.

2. A detailed comparative study of the *Yuktibhāṣā* with the *TS Com.* has been undertaken by the present writer. The said study

his own ; and (3) Rearrange and present, according to the sequence of the verses of the *TS*, the material found distributed in the *Yuktibhāṣā*.

By means of (1) above,. the *TS* Commentator is justified in his description of the work as *Parakroḍāvāsa-dvijavara-samīrito yo'rthaḥ*, 'the exposition that has been well stated (in the *Yuktibhāṣā*) by the brāhmin of the Parakroḍa house'. His justification in mentioning the work as his own, (*cf.*, *mayā kathitaḥ*), lies in the fact that by means of (2) he makes substantial contribution of his own by supplying missing links and offering explanations of his own.

Its being a commentary on the *TS* is substantiated by the fact that in this work each verse or group of verses of the *TS* is introduced in regular sequential order by means of its 'beginning words' (*pratīka-s*) and under the same is given, at times, its regular commentary but generally all that is needed to understand the passage from fundamentals. What is particularly instructive in the *TS Com.* is that the logical exposition of the theory and rationale of a single item often extends over several pages.

6.5. TS Com. is a Com. on the TS

It is suggested by Rajagopal and Rangachari that the *TS Com.* is a Com. on the *TS* rather by proxy than directly, when they say :

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is expected to explain fully the relationship between the two works, besides throwing welcome light on contemporary astronomical concepts and practices in the land.

An anonymous rendering in Sanskrit prose of *Yuktibhāṣā*, under the name *Gaṇita-Yuktibhāṣā*, is available in the Govt. Or. Mss. Library, Madras, R. No. 4382, being a paper transcript prepared from a palmleaf original in the Chirakkal Palace, Chirakkal, (N.Kerala).

The present writer had presumed that this rendering "is also, in all probability, his (Jyeṣṭhadeva's) work." (*Hist. of the Kerala school of Hindu astronomy*, *op. cit.*, p. 60). But a close examination of the work has now revealed that this is a not-so-reliable attempt at literally translating the *Yuktibhāṣā* by some later scholar who was neither well versed in Sanskrit nor properly equipped in the subject.

The original Malayalam manuscript from which the rendering had been made, too, should have had some gaps and other imperfections as can be inferred from the lapses which occur in the rendering.

"*Tantrasaṅgraha-vyākhyā*, though an anonymous work, claims at the end of every chapter, to have derived the material of that chapter from the teachings of a Brahmin of Parakroḍa, now identified with Jyeṣṭhadeva, this material aiming at an elucidation of portions of *Tantrasaṅgraha*, since otherwise the work would not be a *vyākhyā* in the sense intended."[1] It should, however, be clear from the delineation above of its nature and its relationship with the *Yuktibhāṣā* and the *TS*, that the author is fully justified in designating it as a *vyākhyā* on the *TS*. Moreover, a close examination of the *TS Com.* will reveal numerous instances of word by word commentary of the *TS* verses or of key words thereof, and also the incorporation of textual lines in an explanatory manner, so as to leave no doubt about the *TS Com.* being a direct commentary of the *TS*.

6.6. Name of the TS Com. : Yuktidīpikā

In yet another place, the author again calls the work a *vyākhyā*, and also supplies the welcome information regarding its name as *Yuktidīpikā*, 'Lamp of (astronomical) rationale'. Thus, in another work of his, *Laghuvivṛti*, the 'concise commentary' on the *Tantrasaṅgraha*,[2] after giving the meaning of the verses VII. 4-6, the commentator adds : **अत्र विक्षेपस्वरूपं प्रति यद् वक्तव्यं तत् मयैव एतद्व्याख्यायां युक्तिदीपिकायां प्रपञ्चितम् इति तत एव अवधार्यम् ।**

'Here, whatever has to be said about the nature of the celestial latitude (*vikṣepa*), that has been stated by me in great detail (*prapañcitam*) in the *Yuktidīpikā*, *a commentary on this very work* (*Tantrasaṅgraha*). It has, therefore, to be learnt from that (detailed commentary) itself.'

7. IDENTIFICATION OF THE COMMENTATOR ŚAṄKARA

7.1. Relationship of TS Com. with Kriyākramakarī

It is noteworthy that more than four hundred verses of the *TS Com.* in verse edited here occur in parallel contexts also in the

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1. See, 'On an untapped source of medieval Keralite mathematics', quoted earlier, p. xli.

2. For the identification of the authorship of the *TS Com.* and the *Laghu.* and the chronological precedence of the former to the latter, see below, § 8. 1-2, pp. l-lvi.

Kriyākramakarī, which is an extensive and elucidative commentary on the *Līlāvatī* of Bhāskara II,[1] as shown in the following Table.

7.2. Correspondence of verses in TS. Com. and Kriyākramakarī

Subject	*T.S. Com. verses*	*Kriyākramakarī*	*No. of verses*
Guṇakarma	I. 259- 92	1-34 (pp. 16-19)	34
Bhāgaharaṇa-vāsanā	,, 293- 98	1- 6 (,, 22)	6
Vargakarma-vāsanā	,, 299-372	1-74 (., 29-36)	74
Vargamūla-vāsanā	,, 373- 84	2`-31 (,, 43-44)	12
Vargamūla-karma-vāsanā	,, 385- 97	8-20 (,, 42-43)	13
Vargamūlakarma	,, 398-400	1 ff. (,, 41-42)	2
Daśavidhayaḥ	,, 403- 16	Mis. verses (,, 109 ff.)	9
Bhāgajāti-vāsanā	,, 417- 29	1-13 (,, 64-65)	13
Prabhāgajāti-vāsanā	,, 430- 38	1- 8 (,, 68)	8
Bhāgānubandha-Bhāgāpavāha-vāsanā	,, 439- 58	1-20 (,, 73-74)	20
Bhinnaguṇana-vāsanā	,, 459- 71	1-13 (,, 79-80)	13
Bhinnabhāgahāra-vāsanā	,, 472- 86	1-16 (,, 82-83)	16
Bhinnavarga-ghana-vāsanā	,, 487- 94	1- 8 (,, 86)	8
Bhāgānubandha-vāsanā	,, 495- 99	1- 5 (,, 89)	4
Trairāśika	,, 500 ff.	1 ff. (,, 204-9)	27
Jyācāpānayana	II. 461- 79	82-101 (,, 358-60)	20
Tryaśrakṣetranyāya	,, 524- 31	1-8 (,, 317)	8
Vṛttagatacaturaśra	,, 536-616	1-81 (,, 351-58)	81
Do. Do.	,, 647- 48	1, 5 (,, 351, 352)	2
Golapṛṣṭhānayana	,, 752- 94	1-44 (,, 395-99)	44
	Total		414

7.3. Chronological priority of the TS Commentary to Kriyā.

While, in the *Kriyākramakarī*, the verses setting out the rationale of the respective topics are just tacked on to the commentary on the

1. Cr. ed. with Introduction and Appendices by K.V. Sarma, V.V.R. Institute, Hoshiarpur, 1975.

relevant *kārikas* of the *Līlāvatī*, in the *TS Commentary*, these verses are, at times, suitably introduced. *Cf.* :

अथ त्रैराशिकं वक्तुं परिकर्मवितो ब्रुवे ।

Ch. II, Com. verse 209 (p. 22)

वृत्तव्यासधनुर्बाणजीवान्यायं प्रदर्शयन् ।
इत्थं प्रोच्याथ तत्साम्यात् घनगोलफलं ब्रुवे ॥

Ch. II, Com. verse 750 (p. 146)

Since the rationale expounded in the *TS. Com.* often takes the form of a logical dialogue, link words are occasionally interposed between groups of verses giving the different views. *Cf.*, तस्मात् (p. 9), तथा (p. 54), किञ्च (p. 11) यत: (p. 164) etc., which give the work the impression of an organic whole.

While the verses in the *TS Com.* depict the rationale both of mathematics and astronomy, the verses in the *Kriyā.*, in consonance with the contents of the *Līlāvatī*, are concerned only with mathematics. The above considerations point to the chronological priority of the *TS Com.* and suggest that the common verses have been adapted in the *Kriyā.* from the *TS Com.*

7.4. Common authorship of the two works

The common verses in the two commentaries are mostly identical, but, when the context requires, additions, deletions or re-arrangements are effected with such freedom and dexterity as becomes natural to a common author of the two works and not to one who quotes from another. This suggestion of the identification of the authorship of the two commentaries is buttressed by the numerous other verses on other subjects couched in the same diction, occurring exclusively in one or the other of the two works.[1]

7.5. Identification of the author as Śaṅkara

The four available manuscripts of the *TS Commentary*, all of of which are incomplete, not extending beyond ch. IV of the *TS*, do not

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1. For close similarities in language and sense in passages in the two works, see below, § 8.1.1. i-v, pp. li-lvi.

make any mention of its author. However, the author of the *Kriyā-kramakarī*, a work which, too, has been left unfinished, is known to be an eminent mathematician named Śaṅkara. This is specifically stated by Nārāyaṇa who took up the task of completing the incomplete *Kriyā-kramakarī*. This supplementation commences with the following words :

इतीदं गणितविवप्रेसरस्य श्री-हुताशाख्यदेवालय-परिचारकेण शङ्करपारशवेन व्याख्यातम् । तस्य बहुविधव्यापारपारतन्त्र्यात् तत्र व्यापारश्च निवृत्तः । तस्मिन् स्वर्गते पुनर्मया पुरुवनग्रामजेन विप्रेण गृहनाम्ना महिषमङ्गलेन शङ्करात्मजेन निजनाम्ना नारायणेन अष्टादशवयस्केन शिष्यप्रार्थनया अस्मत्पितृनियोगेन च यथाकथंचिदेव व्याख्यानमारब्धम् ।

(*Līlāvatī with Kriyākramakarī*, p. 391)

The above statement identifies the author of the first and main part of the *Kriyākramakarī* (in which portion occur all the verses common with the *TS Commentary*) as Śaṅkara of the Pāraśava community, (called *Vāriyar* in Malayalam), a functionary in the temple of 'Śrī-hutāśa', (being the Sanskritisation of the Malayalam place-name Tṛ-k-kuṭaveli, near Ottappālam in north Kerala).[1]

8. OTHER WORKS OF ŚAṄKARA

8.1. Laghuvivṛti, the concise com. on TS

It is known from other sources that Śaṅkara Vāriyar of Tṛ-k-kuṭaveli is the author also of *Laghuvivṛti*, the 'concise commentary' on the *Tantrasaṅgraha*. Thus, three palmleaf manuscripts of the work, Nos. 8351, 8906 and C. 524 of the Kerala University Oriental Res. Inst. and Mss. Library carry a post-colophonic statement in Malayalam, which reads : *ī vyākhyānam Tṛkkuṭaveli-c-Caṅkara-Vāriyar oṭukkattu camaccatu. Āzhvāñcerikku veṇṭiṭṭu sukhame śikṣiccu camaccu ennu Paraṅṅoṭṭu paraññu keṭṭu*, 'This commentary was composed last by Śaṅkara Vāriyar of Tṛkkuṭaveli. I have heard it said by Paraṅṅoṭṭu that it was composed with great care for the sake of Āzhvāñceri'. The 'Paraṅṅottu' referred to is, obviously, a senior contemporary astronomer, a namputiri brāhmin of the Paraṅṅoṭṭu family, Jyeṣṭhadeva by name and author of the astronomical work *Yuktibhāṣā* in Malayalam.[2] The 'Āzhvāñceri'

1. For details about this identification, see the edn. of *Kriyā.*, Intro., pp. xvi-xviii.

8. On this see, K.V. Sarma, 'Jyeṣṭhadeva and his identification as the author of *Yukibhāṣā*', *Adyar Lib. Bul.*, 22 (1958) 35-40.

mentioned must be a reference to the then head of the Āzhvāñceri Tamprākkaḷ family, being the traditional head of the namputiri brāhmins of Kerala and well-known patrons of scholarship.

It has to be surmised, in the light of the above, that the three commentaries, *viz., Kriyākramakarī* on the *Līlāvatī* and the *Laghuvivṛti* and the larger commentary in verse, both on the *Tantrasaṅgraha,* are of identical authorship, their common author being Śaṅkara Vāriyar of the Tṛkkuṭaveli family.

8.1.1. Similarities in the three works, TS Com., Kriyā. and Laghu.

Interestingly, an examination of the three commentaries referred to above reveals some characteristic similarities which go to substantiate the suggested identity of their authorship.

i. Invocatory verses

At the beginning of the three works, *TS Com., Laghuvivṛti* and *Kriyākramakarī,* the author invokes his personal deities which are the same, *viz.,* God Gaṇeśa and Goddess Sarasvatī, and uses expressions closely resembling each other.

TS Commentary

Gaṇeśa : कारणभूतो जगतां वारणवदनः स विजयतां देवः ।
भक्तजनप्रत्यूहप्रशमनपटुचरितसर्वस्वः ॥ (Intro. to ch. I)

Sarasvatī : करकमलकलितपुस्तकवराभयाक्षस्रजं विशुद्धाङ्गीम् ।
मौलिलसच्चन्द्रकलां त्रिलोचनां भारतीं वन्दे ॥ (Intro. to ch. I)

यत्सेवनतः सद्यः सर्वज्ञत्वं लभेत मूर्खोऽपि ।
कुन्देन्दुस्वच्छतनुं सरस्वतीं तां नमामि सदा ॥ (Intro. to ch. II)

यत्सेवनतः सद्यो लभते मूकोऽपि वावदूकत्वम् ।
कर्पूरामलगात्रीं सरस्वतीं तां नमस्यामि ॥ (Intro. to ch. III)
बालव्युत्पत्तिफलो वाक्प्रसरो यत्प्रसादतो विदुषाम् ।
बालेन्दुलसन्मौलिं वाग्देवीं तां नमस्यामि ॥ (Intro. to ch. IV)

Laghuvivṛti

Gaṇeśa : प्रत्यूहव्यूहविहतिकारकं परमं महः ।
अन्तःकरणशुद्धिं मे विदधातु सनातनम् ॥ (*TSS* edn., p. 1)

Sarasvatī : यत्प्रसादात् कवीन्द्रत्वं मन्दोऽपि लभते क्षणात् ।
तां शारदेन्दुस्वच्छाङ्गीं वन्दे देवीं सरस्वतीम् ॥ (*TSS* edn., p. 1)

Kriyākramakarī

Gaṇeśa : विश्वोत्पत्तिविनाशसंस्थितिविधौ यस्य प्रसादं मुहुः
काङ्क्षन्ते कमलासनाद्रितनयानाथाब्धिजावल्लभाः ।
नित्यं यत्पदपङ्कजे प्रणमतामिष्टार्थसिद्धिर्नृणां
तद् विघ्नौघविघातदक्षचरितं वन्दे गजास्यं महः ॥ (Edn., p. 1)

यस्माद् विश्वस्य सृष्टिस्थितिलयविधयो यत्प्रसादादकार्षी-
दीशः प्लोषं पुराणान् निखिलतनुभृतां यश्च कर्मैकसाक्षी ।
लीलामातङ्गवेषं समजनि शिवयोः पुत्रभावेन यत्तत्
प्रत्यूहव्यूहविध्वंसनपटु जगतां बीजमव्याहतो वः ॥ (Edn., p. 1)

Sarasvatī : वाग्गुम्भान्यत्प्रसादादतिविमलधियः कुर्वते प्राक् कवीन्द्राः
शश्वद् यन्नीरसं तन्नवरसरुचिरं यद्वशाद् भासयन्ति ।
व्याख्यामुद्राक्षमालाभयवरविलसद्बाहुवल्लीं त्रिनेत्रां
वन्दे वन्दारुवृन्दारकमुनिनिकरैर्वन्दितां भारतीं ताम् ॥ (Edn., p. 2)

The following expressions which are either identical or closely similar in form and meaning, relating to the two deities, leave no doubt about their common authorship :

Gaṇeśa :

1. प्रत्यूहप्रशमनपटु	(*TS Com.*)
प्रत्यूहव्यूहविध्वंसनपटु	(*Kriya.*)
प्रत्यूहव्यूहविहतिकारकं	(*Laghuvivṛti*)
विघ्नौघविघातदक्षचरितं	(*Kriyā.*)
2. कारणभूतो जगतां	(*TS Com.*)
जगतां बीजं	(*Kriyā.*)
विश्वोत्पत्ति etc.	(*Kriyā.*)
3. परमं महः	(*Laghu.*)
गजास्यं महः	(*Kriya.*)
4. वारणवदनः	(*TS Com.*)
गजास्यं	(*Krīyā.*)

Sarasvatī :

1.	करकमलकलितपुस्तकवराभयाक्षस्रजं	(*TS Com.*)
	व्याख्याक्षमालाभयवरविलसद्बाहुवल्लीं	(*Kriyā.*)
2.	विशुद्धाङ्गीं	(*TS Com.*, ch. I)
	स्वच्छाङ्गीं	(*Laghu.*)
	स्वच्छतनुं	(*TS Com.*, ch. II)
	अमलगात्रीं	(*TS Com.* ch. III)
3.	यत्सेवनतः सद्यः सर्वज्ञत्वं लभेत मूर्खोऽपि	(*TS Com.*, ch. II)
	यत्सेवनतः सद्यो लभते मूकोऽपि वावदूकत्वं	(„ III)
	यत्प्रसादात् कवीन्द्रत्वं लभते क्षणात्	(*Laghu.*)
	वाग्गुम्भान्यत्प्रसादात् ··· कवीन्द्राः	(*Kriyā.*)
	वाक्प्रसरो यत्प्रसादतो विदुषाम्	(*TS Com.*, ch. IV)
4.	त्रिलोचनां	(*TS Com.*)
	त्रिनेत्रां	(*Kriyā.*)
5.	भारतीं वन्दे	(*TS Com.*, ch. I)
	वन्दे ··· भारतीं तां	(*Kriyā.*)
	वाग्देवीं तां नमस्यामि	(*TS Com.* ch. IV)
	वन्दे देवीं सरस्वतीं	(*Laghu.*)
	सरस्वतीं तां नमस्यामि	(*TS Com.*, ch. III)
	सरस्वतीं तां नमामि सदा	(„ II)

ii. *Similar Introductions*

The introductory verses of the three works bear close similarity. While the former half of an introductory verse of the *Kriyākramakarī* is identical with that in *Laghuvivṛti*, the phraseology of the latter half is identical with the corresponding portion in the introductory verse of the *TS Com. Cf.* :

नारायणं जगदनुग्रहजागरूकं
श्रीनीलकण्ठमपि सर्वविदं प्रणम्य ।
व्याख्यां क्रियाक्रमकरीं रचयामि लीला-
वत्याः कथंचिदहमल्पधियां हिताय ॥ (*Kriyā.*, Intro. verse 4)

नारायणं जगदनुग्रहजागरूकं
श्रीनीलकण्ठमपि सर्वविदं प्रणम्य ।

यत् तन्त्रसंग्रहगतं ग्रहतन्त्रजातं
तस्यापरां च विवृतिं विलिखामि लघ्वीम् ॥

(*Laghu.*, Intro. verse 3)

यत् तन्त्रसंग्रहं नाम पूर्वैः प्रकरणं कृतम् ।
हितायाल्पधियां तस्य पद्यैर्व्याख्या विलिख्यते ॥

(*TS Com.*, Intro. verse 3)

iii. *Characteristic colophons*

The colophons occurring at the close of the several chapters in the *TS Com.* and *Laghu.* are all couched in verse form, which itself is an uncommon feature, in the very same metre. Moreover, the final quarters of these concluding verses are surprisingly similar. Compare, for instance, the concluding *pādas* in the works as given below :

	TS Com.	*Laghu.*
Ch. I.	प्रथमेऽध्याये मया कथितम् ।	प्रथमोऽध्यायः प्रपूर्णोऽभूत् ।
„ II.	प्रोक्तोऽध्याये द्वितीयेऽभूत् ।	पूर्णोऽध्यायो द्वितीयोऽभूत् ।
„ III	प्रोक्तोऽध्याये तृतीये सः ।	पूर्णोऽध्यायस्तृतीयोऽभूत् ।
„	प्रोक्तोऽध्याये चतुर्थेऽभूत् :	पूर्णोऽध्यायश्चतुर्थोऽभूत् ।

The closeness of the passages indicates the same individualistic way of wording the idea.

iv. *Individualistic expressions*

Among characteristic expressions amounting to mannerisms in the three commentaries might be mentioned the words *savistaram*, *spaṣṭataram* and *vistarataḥ* which occur frequently. *Cf.* :

मध्यमानयनोपायमित्थं प्रोच्य सविस्तरम् । (*TS. Com.*, p. 78)

वृत्तव्यासधनुर्बाणजीवान्यायं सविस्तरम् । (*TS Com.*, p. 146)

अर्कादीनां स्फुटविधिमित्थं प्रोच्य सविस्तरम् । (*TS Com.*, 186)

स्फुटीकरणं विस्तरतः प्रदर्शितम् । (*Laghu.*, *TSS* edn., p. 47)

दृग्गोलविषयं स्पष्टतरं प्रदर्शितम् । (*Laghu.*, below, p. 311)

व्यतीपातस्वरूपं विस्तरतः प्रदर्शितम् । (*Laghu.*, below, p. 320)

दृक्कर्मयुगलं स्पष्टतरं प्रदर्शितम् । (*Laghu.*, below, p. 326)

गणितं विस्तरतः प्रदर्शितम् । (*Kriyā.*, p. 277)

v. *TS Com. and Laghu. comments compared*

Notwithstanding the difference in approach between the *TS Com.* and *Laghu.*, which preclude repetitive exposition, close verbal similarity can be detected at places. The commentary on the very first verse of the *Tantrasaṅgraha* is an illustration in point :

Text : हे विष्णो निहितं कृत्स्नं जगत् त्वय्येव कारणे ।
ज्योतिषां ज्योतिषे तस्मै नमो नारायणाय ते ॥ (*TS* I. 1)

On this *TS Com.*, comments :

मृत्तिकायां यथा **भाति कृत्स्नं कुम्भघटादिकम्** ।
नारायणे तथा भाति **जगद्** एतच्चराचरम् ॥ ४ ॥

जगत्कारणता तस्य निर्विवादा स्थिता ततः ।
ज्योतिष्ट्वं ज्योतिषां तस्य ज्ञेया **भगवदुक्तितः** ॥ ५ ॥

"**यदादित्यगतं तेजो जगद् भासयतेऽखिलम्** ।
यच्चन्द्रमसि यच्चाग्नौ तत्तेजो विद्धि मामकम् ॥ ६ ॥
(भगवद्गीता, २५.२)

इति यत् किल **गीतायामुक्तं भगवता** स्वयम् ।
नारायणाख्यया नाम्नःसहस्रमुपलक्षितम् ॥ ७ ॥
(See below, pp. 1-2)

The close verbal parallelism to the above passage borne by the *Laghuvivṛti* would be apparent from an examination of the following extract from that commentary :

यस्मिंस्त्वयि **कृत्स्नमिदं जगत्** निहितं **भाति घटशरावादिकमिव मृत्तिकायां**, तस्मै ते नमोऽस्तु ।

कीदृशाय ? **ज्योतिषां** सूर्यतारकादीनामपि **ज्योतिषे । यदुक्तं गीतायां भगवदुक्तौ**—

यदादित्यगतं तेजो जगद् भासयतेऽखिलम् ।
यच्चन्द्रमसि यच्चाग्नौ तत्तेजो विद्धि मामकम् ॥
(भगवद्गीता, २५. २)

इति । पुनरपि कीदृशाय ? नारायणाय । **उपलक्षणमेतत् नामान्तराणामपि** ।
(*Laghu.*, *TSS* edn., pp. 1-2)

It may be noted that the words set in black type in the extracts from the two commentaries are either identical or convey the same sense.

In pursuance of its set purpose (*vide* Intro. verse 3) to compose a 'concise' (*laghu*) commentary (*vivṛti*) 'confined to spell out briefly the

methods of computation enunciated in the *Tantrasaṅgraha*' (*Tantrasaṅgrahasya kriyākalāpam krameṇa saṅgṛhya*), the *Laghuvivṛti* is necessarily brief and matter of fact. Still, in an instance or two (see pp. 23, 69 of the *TSS* edn.), it exhibits the flair for the elegant and elaborate versification of astronomical phenomena that characterises the entire length of the *TS Commentary*.

8.1.2. TS Commentary earlier to the Laghuvivṛti

In this context, it is worth noting that the *Laghuvivṛti* itself states that its author had composed *earlier* an elaborate commentary on the *Tantrasaṅgraha*. *Cf.* :

यत् तन्त्रसंग्रहगतं ग्रहतन्त्रजातम् ।
तस्यापरां च विवृतिं विलिखामि लघ्वीम् ॥ (Ch. I, Intro. verse 3)

'The collocation of planetary computations contained in the *Tantrasaṅgraha*—of that, I am (again) writing, in concise form (*laghvīm*), still another commentary (*aparām ca vivṛtim*).'

The extensive commentary in verse edited here answers fully for the larger commentary implied in the above citation.

8.1.3. The Laghu. author quotes TS Com. as his own work

Clinching evidence for the identity of the authorship of *Laghu.* and *TS Com.* comes from the *Laghu.* itself, when its author quotes lines from the *TS Com.* as his own earlier composition. Thus, concluding his comments on *TS* I. 16, he says : **तत्र लब्धस्य वर्गे तद्बाणवर्गं सव्यंशं क्षिप्त्वा मूलिकुर्यात् । ··· तदुक्तं मया—**

अन्योन्यकोटिहतयोर्भवासन्नदोर्ज्ययोः ।
त्रिज्याप्तवर्गे तद्बाणवर्गं सव्यंशकं क्षिपेत् ॥
तन्मूलमधऊर्ध्वस्थचापसन्धेर्धनुर्भवेत् ।
तद्युक्तोनं स्याधऊर्ध्वचापसन्धिधनुर्धनुः ॥ (*TSS.* edn. of *TS*, p. 23)

These lines occur in the *TS Com.*, in the same context, as verses II. 799b-801a (see below, pp. 150-51), thereby conclusively establishing the identity of the authorship of the two commentaries.

8.1.4. Laghu. a complement to TS Com.

It would be necessary, here, to make clear a point which has only been hinted at earlier, *viz.*, that the ***Laghu.*** forms a complement

to the *TS Com.* While the *TS Com.* explains elaborately the mathematical and astronomical rationales involved in the *TS*, the *Laghu.* is primarily concerned with a statement of the collocation of calculations (*krlyā-kalāpa*) enunciated in the *TS* verses. And, when needed, the larger commentary is called attention to in the smaller commentary. *Cf.*, the passage quoted earlier : **अत्र विक्षेपस्वरूपं प्रति यद् वक्तव्यं तत्** मयैव एतद्व्याख्यायां युक्तिदीपिकायां प्रपञ्चितम् **इति तत एव अवधार्यम्** । (See below, p. 322).

This method of exposition seems to be a characteristic of the author, for it is found also in his commentary *Kriyākramakarī* on the *Līlāvatī*. The only difference in that work is that both the items, *viz.*, the terse, matter of fact prose meaning and the poetic elaboration of the rationale are given in the same volume, one following the other.

8.1.5. 'Kriyākalāpa' : An expression wrongly interpreted

The concise commentary *Laghuvivṛti* has, at the close of its several chapters, a common verse which reads as follows :

इति तन्त्रसंग्रहस्य क्रियाकलापं क्रमेण संगृह्य ।
रचिते तद्व्याख्याने प्रथमोऽध्यायः प्रपूर्णोऽभूत् ॥[1]

'Of the commentary of *Tantrasaṅgraha* wherein its collocation of calculations (*kriyākalāpa*) has been duly and concisely explained, the first chapter has ended.'[1]

The expression *Kriyākalāpa* had been interpreted previously to mean the larger commentary implied in the introductory verse cited above.[2] The occurrence of a catalogue entry in the Kerala University

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1. In the concluding commentarial verses of the other chapters, while the first three quarters of the verse are retained as such, the last quarter has been re-worded to suit the metre. *Cf.* :

Ch. II : पूर्णोऽध्यायो द्वितीयोऽभूत् । Ch. III : पूर्णोऽध्यायस्तृतीयोऽभूत् । Ch. IV : पूर्णोऽध्यायश्चतुर्थोऽभूत् । Ch. V : पूर्णोऽभूत् पञ्चमोऽध्यायः । Ch. VI : षष्ठोऽध्यायः प्रपूर्णोऽभूत् । Ch. VII : पूर्णोऽभूत् सप्तमोऽध्यायः । Ch. VII : पूर्णोऽभूदष्टमोऽध्यायः ।

2. See K.V. Sarma, *A Bibliography of Kerala and Kerala-based astronomy and astrology*, (Hoshiarpur, 1972), p. 46 ; Edn. of *Līlāvatī* with *Kriyākramakarī*, *op.cit.*, Intro., p. xix.

Oriental Res. Institute and Mss. Library as *Tantrasaṅgraha-(vyākhyā) Kriyākalāpaḥ* (Ms. No. L. 1329-A, *Alphabetical List of Skt. Mss.*, vol. II, p. 17) had created this impression. However, further investigations have shown that the commentary contained in the said manuscript is only the *Laghuvivṛti,* to which the name *Kriyākalāpa* has been wrongly given there.[1] The same wrong ascription of the name is found also in the Ms. A used for the critical edition of *Laghuvivṛti* in the present publication. In this old palmleaf ms., the owner's name, given in Malayalam, reads : *Vāraṇāsiye Kriyākalāpam Tantrasaṅgraha-vyākhyānam*', 'The *Kriyākalāpam* : *Tantrasaṅgraha*-commentary belonging to the (the family of) Vāraṇāsi.'

Equally erroneous is the interpretation 'astronomical portion' given to the expression *kriyākalāpa* by M. Winternitz, who describes a complete manuscript of '*Tantrasaṅgraha* with the commentary *Laghuvivṛti*', deposited in the Royal Asiatic Society, London, thus : "The *Kriyākalāpa* ('astronomical portion') of the *Tantrasaṅgraha,* in 8 *adhyāyas* with a commentary."[2] The mention of the work in *Kerala Sanskrit literature* : *A bibliography* by S. V. Iyer, (Trivandrum, 1976, p. 247) under the title "*Tantrasaṅgraha Kriyākalāpa-vyākhyā,* Anon., RAS, London," is obviously based on this ms. and, so, is incorrect.

Obviously, the quaintness of the expression *Kriyākalāpa* and the occurrence of the word *saṅgṛhya* in the colophonic verses in the *Laghu.* have given rise to the above interpretations. The fact is that the expression *Tantrasaṅgraha-kriyākalāpam* found in the said colophonic verse at the close of the different chapters of *Laghuvivṛti,* has only its literal meaning, *viz.*, 'the collocation of computations of the *Tantrasaṅgraha*' and does not refer to any commentary on the work nor to any

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1. It may be noted, in this connection, that the initial part of the said manuscript has been lost and that it begins with the words : *tatra tāvat kalyāder ārabhya yātān abdān dvādaśabhir nihatya,* etc. ; this passage occurs in the *Laghuvivṛti,* on *TS* I. 23-26 (*TSS* 188, p. 9). Also, the extent of this ms. is only 2000 *granthas,* while that of the *Laghuvivṛti,* is 2500 *granthas.*

2. Ms. 134, described in *A catalogue of South Indian manuscripts (especially those of the Whish collection) belonging to the Royal Asiatic Society of Great Britain and Ireland,* compiled by M. Winternitz., London, 1902, p. 190.

part of that work. The larger commentary implied in the introductory verse is to be identified with *TS Com. Yuktidīpikā* referred to by Śaṅkara himself in the *Laghu.* on *TS.* VII. 4-6 (p. 322 below).

8.2. Pañcabodha-vyākhyā

Two manuscripts of Śaṅkara's *Kriyākramakarī*, one of them being Ms. No. R. 2754 (a) of the Madras Govt. Or. Mss. Library, and the other with the present editor, contain, in continuation thereof, an incomplete commentary on *Pañcabodha* IV, an anonymous work on astronomy of the *Karaṇa* type, divided into five sections devoted to *Vyatīpāta*, *Grahaṇa*, *Sṛṅgonnati*, *Chāyā* and *Mauḍhya*. This commentary, also called *Laghuvivṛti*, commences with invocatory verses which closely resemble the invocatary verses in the *Kriyā.*, *Laghu.* and *Yukti. Cf.*:

भास्वन्तमन्धतमसप्रध्वंसप्रथितत्विषम् ।
अन्तरज्ञानतिमिरसमुच्छेदाय संश्रये ॥ १ ॥
समस्तान्यपि कर्माणि **निष्प्रत्यूहं** समाप्नुयुः ।
यस्य प्रसादात् तं वन्दे **गजवक्त्रं** महः सदा ॥ २ ॥
यत्प्रसादात् कवीन्द्रत्वं मन्दोऽपि लभते क्षणात् ।
तां शारदेन्दुस्वच्छाङ्गीं वन्दे देवीं सरस्वतीम् ॥ ३ ॥
शक्त्या शश्वन्निखिलसुमनस्संहतिस्तद्विपक्षं
जित्वा सद्यो निजनिजपदे स्थापिता यस्य भाति ।
अक्षोभ्यः सन् निखिलजगतां वन्द्यपादः सुशीलः
सुब्रह्मण्यः स जयतितमां **नीलकण्ठावलम्बी** ॥ ४ ॥

नारायणं जगदनुग्रहजागरूकं
विद्वत्तमं गुणनिधिं सुहृदं प्रणम्य ।
लाटादिपञ्चकविबोधकरस्य **पञ्च-**
बोधस्य चारुविवृतिं विलिखामि लघ्वीम् ॥ ५ ॥

It is remarkable that the invocatory verse 3, above, is identical with the second introductory verse of *Laghu.* and that verse 5 closely resembles the parallel verses in the *Kriya.* and *Laghu.* The several other expressions that bear similarity in form or sense with *Yukti.*, *Kriyā.* and *Laghu.* have been set off in bold type.

Two complete manuscripts of the work are known, being Mss. No. 411-A and T. 1184 of the Kerala University Or. Mss. Library.

Neither of them contains any indication of the name of the author, though his teacher and the Kali date of the completion of the work are mentioned. *Cf.* : इति नारायण-पूज्यपादप्रियशिष्यविरचिते पञ्चबोधव्याख्याने पञ्चमः परिच्छेदः । समाप्तं चेदम् । श्रीसुब्रह्मण्याय नमः ।

16,91,302
'प्राज्ञलोकोद्धृतं यत्नाद्' गूढमर्थं विवृण्वती ।
व्याख्येयं पञ्चबोधस्य चिरं तिष्ठतु भूतले ॥

The commentary is explicit and elaborate, several points being logically argued as in the *TS Com. Yuktidīpikā*. Citations to substantiate statements are given from several authorities including the *Laghubhāskarīya* and *Mahābhāskarīya* of Bhāskara I, *Siddhāntaśekhara* of Śrīpati, *Laghumānasa* of Muñjāla and the *Siddhāntadarpaṇa* of Nīlakaṇṭha. The *Tantrasaṅgraha* is quoted extensively. A large number of citations are made anonymously and some are introduced with the expression *taduktam amunaiva anyatra*, referring to other works of the author of *Pañcabodha* IV. Some of the topics are summed up through verses, apparently, composed by the commentator himself and reminiscent of similar summing up in his *Kriyākramakarī* and *TS Com. Yuktidīpikā*.

8.3. Karaṇasāra

An original work which has to be ascribed to Śaṅkara on the basis of a closely parallel invocatory verse and other considerations is the astronomical manual *Karaṇasāra*. In four chapters, this work enunciates simplified methods for the several day to day astronomical computations.[1] The work begins thus :

आमात्यद्वयवन्ताढ्यं दन्तावलमुखं महः ।
निरन्तरान्तरायान्तःकरणोन्निद्रशक्तिमत् ॥ १ ॥

जयन्ति मानसाम्भोजमकरन्दसहायिनः ।
चन्द्रचूडेन्दुनिःश्वासाः परमानन्ददायिनः ॥ २ ॥

The author, next names his teacher Nīlakaṇṭha and his grand-teacher Dāmodara and the object of his work :

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1. Mss : Kerala Univ. Mss. Lib., Nos. C. 8-A, C. 173-F, C. 173-K.

श्री-नीलकण्ठमाचार्यं श्रीमद्-दामोदरं गुरुम् ।
प्रणम्य लिख्यते किञ्चिद् गणितं सुलघुक्रियम् ॥ ३ ॥

The date of composition of the work can be inferred to be about A.D. 1554 from the epoch adopted by the author for commencing computations, *viz.*, *anūnajñānasādhya* (Kali day 17,00,000) which falls in that year.

A detailed commentary on the work in Malayalam is known.[1] This commentary calls itself *Bhāṣāvivaraṇam* and quotes from several works, especially the *Tantrasaṅgraha* of Nīlakaṇṭha. A post-colophonic verse carries a name Śaṅkara who, from the context, is more likely to be the scribe of the manuscript than the author of the commentary. *Cf.* : इति करणसारस्य भाषाविवरणे चतुर्थोऽध्यायः ॥

व्याख्यामेवं मन्दबोधार्थमस्य पूर्वैरुक्तां गोलविद्भिर्विदग्धैः ।
एतां गोलालोकने दर्पणाभां सुव्यक्तार्थामालिखं शङ्करोऽहम् ॥

8.4. Chronology of Śaṅkara's works

It is possible to fix, from the information collected above, the chronological sequence of the known works of Śaṅkara. His *Pañcabodha-vyākhyā* gives, as noticed earlier, the date of its completion through the Kali date *prājñālokoddhṛtam yatnāt* (16,91,302), which falls in A.D. 1529 (see above, p. lx). The *Kriyākramakarī* illustrates the calculation of Kali days through a problem which gives the answer as a past Kali day 16,92,972, which falls in A.D. 1534. The nature of this problem would seem to indicate that this is a known past but contemporary date. This would mean that the work was written later but not much later than this date. Since the *Kriyā.* incorporates more than 400 verses from the *TS Com.* (*Yuktidīpikā*), the date of composition of the latter work should, obviously, precede that of the latter. The date of the *Karaṇasāra* has to be later than the epoch it uses to commence calculations, *viz.*, Kali day *anūnajñanasādhya*

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1. Mss. Kerala Univ. Mss. Lib. Nos. C, 8-B, C. 173-J, TM. 1042.

(17,00,000), which falls in A. D.1554. The *Laghuvivṛti* on the *Tantrasaṅgraha* has been mentioned in a post-colophonic statement in some of its manuscripts as the work that Śaṅkara composed last (see above, p. l). Elsewhere, the work has been stated to have been composed in about M.E. 731 (A.D. 1556).[1]

9. ŚAṄKARA, THE COMMENTATOR

1. Personal details

Since Śaṅkara is rather reticent about giving his biographical details, such information has to be extracted from other sources. As stated earlier, Śaṅkara had left his *Kriyākramakarī* unfinished and the completion thereof was undertaken by a younger contemporary, Nārāyaṇan Nampūtiri of the Mahiṣamaṅgalam family. Introducing his supplement, Nārāyaṇa says :

इतीदं गणितविदग्रेसरेण श्री-हुताशाख्य-देवालयपरिचारकेण शङ्कर-पारशवेन व्याख्यातम् । तस्य बहुविधव्यापारपारतन्त्र्यात् तत्र व्यापारश्च निवृत्तः । तस्मिन् स्वर्गते पुन: मया पुरुवनग्रामजेन विप्रेण गृहनाम्ना महिषमङ्गलेन शङ्करात्मजेन निजनाम्ना नारायणेन अष्टादशवयस्केन शिष्यप्रार्थनया अस्मत्-पितृ-नियोगेव च यथाकथंचिदेव व्याख्यानमारब्धम् ।

(*Līlāvatī with Kriyākramakarī*, *op.cit.*, p. 391)

'This (work, *viz.*, *Līlāvatī*) has been commented thus far by Śaṅkara-Pāraśava, the foremost among astronomers, who was a functionary of the temple Śrī-hutāśa by name. On account of his multifarious activities, his application in the matter came to an end. At his death, (the supplementation of) the commentary was somehow commenced by me, aged eighteen, son of Śaṅkara,[2] Nārāyaṇa by name, a brāhmin of the village Puruvana and house-name Mahiṣamaṅgala, on the entreaty of pupils and at the command of my father.'

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1. See Ulloor, *Kerala Sahitya Charitram*, Vol. II, (Trivandrum, 1954), p. 120. The source of the information is not indicated, but it is likely to be correct.

2. This namesake of our author was the renowned contemporary astronomer Śaṅkaran Nampūtiri of the Mahiṣamaṅagalam family (A.D. 1494-1573), on whom see K.V. Sarma, *Hist. of the Kerala school of Hindu astronomy*, *op.cit.*, pp. 62-64.

The post-colophonic statement in Malayalam to certain manuscripts of the *Laghuvivṛti* of Śaṅkara or *Tantrasaṅgraha* reads :

ई व्याख्यानं तृक्कुटवेलि-च्-चङ्करवारियर् ओटुक्कत्तु चमच्चतु ।
(*Mss.* Kerala Uni. Mss. Lib., Nos. 8351, 8906, C. 524)

'This commentary was composed last by *Tṛkkuṭaveli*-c-Caṅkara-Vāriyar.'

It is well known that *pāraśava* is the Sanskrit term used to denote the sub-sect of external functionaries of Keralite temples called *Vāriyar* in the local language. It has also been shown that *Śrī-hutāśa* ('Śrī-fire') is the Sanskrtised form of the place-name Tṛ-k-kuṭaveli denoting the temple-town of Tṛkkoṭīri near Ottappalam in Malabar.[1]

Piecing together the said bits of information we learn that the commentator was named Śaṅkara, belonged to the Hindu sub-sect *Vāriyar*, and was an external functionary at the temple of Tṛkkoṭīri in Malabar (Kerala). Enquiries made by the present editor have revealed that the presiding deity at Tṛkkoṭīri is God Śiva with, Gaṇeśa and Sarasvatī as secondary deities, and that attached to that temple there is even today a Vāriyar family called Tṛkkoṭīri-vāriyam, though scholarship in the family is much in the wane.

9.2. Śaṅkara's teachers and promoters

1. *Nīlakaṇṭha* (A.D. 1444-1545) *and Dāmodara* (*c.* 1410-1520)

The prime preceptor of Śaṅkara is obviously Nīlakaṇṭha, author of *TS* and other works, whom he refers to as *sarva-vid* 'knower of all (*śāstras*)' in the introductory verses to the *Kriyā*. and the *Laghu*. *Cf.* :

श्री-नीलकण्ठमपि सर्वविदं प्रणम्य ।

In the *Karaṇasāra*, besides the teacher Nīlakaṇṭha, his father Dāmodara, is referred to as Śaṅkara's grand-teacher. *Cf.* :

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1. See *Līlāvatī with Kriyākramakarī*, *op.cit.*, Introduction, p. xvii.

श्री-नीलकण्ठमाचार्यं श्रीमद्-दामोदरं गुरुम्[1] ।
प्रणम्य लिख्यते किञ्चिद् गणितं सुलघुक्रियम् ॥

In the *Yuktidīpikā*, Śaṅkara cites Nīlakaṇṭha's *Golasāra* as that of his own *'guru'* (teacher). *Cf.* :

गुरुभिः स्फुटकर्मेत्थं गोलसारे प्रदर्शितम् ।
(Com. verse, II. 1010, p. 177)

In the *Laghu.*, Nīlakaṇṭha's works are frequently quoted and introduced sometimes with the term *ācāryeṇa* (*TSS* edn., p. 15) and sometimes without. Some of these quotations cannot be traced to the available works of Nīlakaṇṭha, indicating the possibility of their being stray verses of Nīlakaṇṭha or verses from his other works which are not now available. Passages from Nīlakaṇṭha are profusely quoted, in a similar manner, also in the *Pañcabodha-vyākhyā* of Śaṅkara.

2. *Nārāyaṇa, the Āzhvāñceri Tamprākkaḷ* (A.D. 1435-1535)

Another teacher of Śaṅkara was Nārāyaṇa, a distinguished *āḍhyan namputiri*, of the Kauṣītaka-gotra, who was an Āzhvāñceri Tamprākkaḷ, the religious head of the namputiri brāhmins of Kerala, with his seat at Āzhvāñceri in South Malabar, and having the title *Netranārāyaṇa*. To Śaṅkara, Nārāyaṇa, besides being a teacher, was also a benefactor and patron. In the colophons to his *Pañcabodha-vyākhyā*, Śaṅkara describes himself as a 'favourite disciple of the revered Nārāyaṇa'. *Cf.* : इति श्री-नारायणपूज्यपाद-प्रियशिष्य-विरचिते पञ्चबोधव्याख्याने पञ्चमः परिच्छेदः ।

Again, towards the beginning of the abovesaid work, Nārāyaṇa is described as 'intent on benefitting the world, an erudite scholar and the abode of good qualities'. *Cf.* :

नारायणं जगदनुग्रहजागरूकं[2] विद्वत्तमं गुणनिधिं सुवृतं प्रणम्य ।

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1. The Malayalam com. on the *Karaṇasāra* specifies Dāmodara as the *paramaguru* (grand-teacher). *Cf.* : पिन्ने तन्टे परमगुरुविनेयुं गुरुविनेयुं नमस्करिच्चिट्टु चिकीर्षितप्रतिज्ञ चेय्युन्नू । On Dāmodara, see K.V. Sarma, *Hist. of the Kerala school of Hindu astronomy, op.cit.*, pp. 54-55.

2. This line occurs in the introductory verses also of the *Krīya.* and the *Laghu.*

Nārāyaṇa was an elder contemporary, friend and patron also of Nīlakaṇṭha (1445-1545), author of *TS* and other works (see above, pp. xxvi-xxvii). Indeed, as already mentioned, Nīlakaṇṭha wrote his *Āryabhaṭīya-Bhāṣya* at the instance of Nārāyaṇa. In this regard Nīlakaṇṭha says :

यन्मयात्र केषांचित् सूत्राणां तद्युक्तीः प्रतिपाद्य कौषीतकिनाढ्येन नारायणाख्येन व्याख्यानं कारितम्। अतस्तदेवात्र लिख्यते। (*TSS*, 101, p. 113) ; इतीदं प्रथमे वयस्येव वर्तमानेन मया द्वितीये वयसि स्थितेन कौषीतकिना आढ्येन कारितम्। ···तस्मिन् स्वर्गते पुनः ··· व्याख्यानमारब्धम्। (*TSS*, 101, p. 156).

These statements necessarily mean that the Narāyaṇa and Nīlakaṇṭha had found a common interest in astronomy in which discipline they held fruitful discussions. One of the results of these discussions was the *Āryabhaṭīya-Bhāṣya*, though Nīlakaṇṭha actually commenced writing the *Bhāṣya* only after the demise of Nārāyaṇa. To have been the teacher and patron both of Nīlakaṇṭha (1444-1545) and of Śaṅkara (1500-60), Nārayaṇa should have lived to a grand old age, from about A.D. 1435 to 1535.[1]

3. *Jyeṣṭhadeva* (A.D. 1500-1610)

As noted earlier, in the concluding verses of the different chapters of his *TS Com.*, Śaṅkara states that he had presented in the preceding verses the matters set out by a 'brāhmin of the Parakroḍa family.' *Cf.*, for instance :

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1. A post-colophonic statement in Malayalam to certain manuscripts of Śaṅkara's *Laghu.* on *TS* says, as noted earlier, that that work 'had been composed with care for the sake of Āzhvāñceri' (*Āzhāñcerikku veṇṭiṭṭu sukhame śikṣiccu camaccu*) (see above, p. l). While the expression *Āzhvāñceri* naturally stands for *Āzhvāñceri Tamprākkaḷ*, it need not necessarily stand for the elder Āzhvāñceri Tamprākkaḷ, *viz.*, Śaṅkara's teacher Nārāyaṇa, who, for reasons stated above, should have passed away by A.D. 1535, long before Śaṅkara composed the *Laghu.* in about 1556. The 'Āzhvāñceri' meant here should, therefore, be his successor who continued to extend to Śaṅkara the patronage which his predecessor had been extending to him.

इत्येष परकोडावासद्विजवरसमीरितो योऽर्थः ।
स तु तन्त्रसंग्रहस्य प्रथमेऽध्याये मया कथितः ॥

(*TS Com.*, I. 821, p. 77)

It has also been noted that the 'brāhmin' referred to was a Namputiri of the Paraṅṅoṭṭu family, by name Jyeṣṭhadeva, and the expression *samīrito yo'rthaḥ*, 'the meaning expounded' referred to his Malayalam work *Yuktibhāṣā*. While the verse quoted above does not warrant Śaṅkara being a formal disciple of Jyeṣṭhadeva, the intellectual indebtedness of Śaṅkara to *Jyeṣṭhadeva* is explicit in the paraphrasing of substantial sections of the Malayalam *Yuktibhāṣā* in his Sanskrit *Yuktidīpikā* (*TS Com.*), which Śaṅkara dutifully acknowledges in the verse extracted above.

The *Yuktibhāṣā*, which has been referred to earlier in several contexts, is an elaborate treatise in two Parts, devoted, respectively, to the logical elucidation of Mathematics and Astronomy, and is perhaps, one of the most instructive texts of the type produced during mediaeval times.[1] Another work attributed to Jyeṣṭhadeva is the *Dṛkkaraṇa*, a comprehensive astronomical manual in Malayalam verse. It is divided into ten sections called *paricchedas* and gives the date of its composition in its concluding line as :

Kolambe 'barhisūnau' vihagagatiyatum nokki ittham camappū /

'Compute thus substracting the planetary positions given for the Kollam year *barhisūnu* (783) (=A.D. 1607-8).

An old astronomical document in palmleaf, written in Malayalam script, at the end of a manuscript of a Malayalam commentary on *Sūryasiddhānta*, preserved in the Oriental Institute, Baroda, (No. 9886)[2]

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1. While Part I of this work has been edited with detailed Notes by Rama Varma Maru Thampuran and A.R. Akhileswara Iyer (Trichur, 1948), an edition of Part II with Notes is in preparation by the present editor.

2. For an edition and study of this interesting document which gives the names and records the writings of several Kerala astronomers, see, K.V. Sarma, 'Direct lines of astronomical tradition in Kerala', *Charudeva Shastri Felicitation Volume*, (Delhi, 1973), 601-4.

contains some welcome information about our author. The relevant passage reads ;

पूर्वोक्तस्य दामोदरस्य शिष्यः ज्येष्ठदेवः। इद्देहं परङ्ङोट्टु-नम्पूतिरियाकुन्नू। युक्तिभाषा-ग्रन्थत्ते उण्टाक्कियतुं इद्देहं तन्ने।

ज्येष्ठदेवन्टे शिष्यन् तृक्कण्टियूर अच्युतपिषारटि। इद्देहं स्फुटनिर्णयं, गोलदीपिका मुतलाय ग्रन्थकर्तावाकुन्नू।

'Jyeṣṭhadeva is the disciple of Dāmodara mentioned earlier. He is a Nampūtiri of Paraṅṅoṭṭu (family). It was he who composed the work *Yuktibhāṣa*.

'Tṛkkaṇṭiyūr Acyuta Piṣāraṭi is the pupil of Jyeṣṭhadeva. He is the author of *Sphuṭanirṇaya, Goladīpikā* and other works.'

Apart from corroborating some of the information gleaned from other sources, the above-quoted document provides some additional details. Thus, the astronomer Dāmodara, teacher of Nīlakaṇṭha, was the teacher also of Jyeṣṭhadeva. Jyeṣṭhadeva was, obviously, a younger contemporary and pupil also of Nīlakaṇṭha, for, in the *Yuktibhāṣa* composed with a view to elaborating the rationale of the latter's *TS*, Jyeṣṭhadeva quotes a verse from Nīlakaṇṭha's *Siddhāntadarpaṇa* with the prefatory statement :

इप्रकारत्ते उण्टु चोल्लीट्टु सिद्धान्तदर्पणत्तिल् आचार्यन् etc.

'This procedure has been stated in the *Siddhāntadarpaṇa* by the Teacher (Nīlakaṇṭha)' (p. 64 of the present editor's press copy of Pt. II of *Yuktibhāṣa*).

The mention, in the above-quoted document, about Jyeṣṭhadeva's being the teacher of Acyuta Piṣāraṭi (A.D. 1550-1621), who wrote the *Sphuṭanirṇaya*[1] and other works, is corroborated Acyuta himself in the closing verse of his *Uparāgakriyākrama*. *Cf.* :

'प्रोक्तः प्रवयसो ध्यानात्' ज्येष्ठदेवस्य सद्गुरोः।
विच्युताशयदोषेणेत्यच्युतेन क्रियाक्रमः॥

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1. Cr. ed. by K.V. Sarma, with Auto-commentary, Introduction and Ten Appendices, (Hoshiarpur, 1974).

'(The work *Uparāga)kriyākrama* has (thus) been set out by Acyuta, bereft of mental confusion on account of his contemplating on his aged and noble teacher Jyeṣṭhadeva.'

An early Malayalam commentary explains that the expression *proktaḥ pravayaso dhyānāt* in the above-quoted verse gives, in *kaṭapayādi* notation, the Kali day of the completion of the *Uparāgakriyākrama, viz.*, 17,14,262 (=A.D. 1592). Jyeṣṭhadeva who was 'very old' (*pravayasaḥ*) in 1592, should have lived up to about A.D. 1610, since he is said to have composed the *Dṛkkaraṇa* in A.D. 1607-8.

4. *Citrabhānu* (A.D. 1475-1550)

A senior contemporary astronomer whom Śaṅkara quotes with respect and possibly, might have received instruction from, is Citrabhānu, a namputiri brāhmin of the Gautama-gotra, who belonged to the village of Covvaram (Skt. Śivapuram) near Trichur in Central Kerala. Śaṅkara quotes extensively, in his *Kriyākramakarī*, from Citrabhānu's *Ekaviṁśati-praśnottara*. He adds also his own exposition to Citrabhānu's *kārikās*, which are introduced with the following prefatory statement :

अत्र राश्योः योग-भेद-घात-वर्ग-घन-तन्मूलेषु द्वाभ्यां द्वाभ्यां विदिताभ्यां राशिद्वयानयनं एकविंशतिधा कार्यमित्युपदिष्टं चित्रभानु-नामक-गणितगोलयुक्तिविदग्रेसरेण भूसुरोत्तमेन । तत्र दिङ्मात्रम् अस्माभिः तदुपदेशवशादिह लिख्यते ।

(*Līlavatī with Kriyākramakarī, op.cit.*, pp. 109-25)

'Now, of two numbers, if from among their sum, difference, product, squares, cubes and the (square and cube) roots, sets of two each are known, the (original two) numbers can be calculated, through methods enunciated by the respected (namputiri) brāhmin named Citrabhānu, foremost among mathematicians and astronomers. Herein-below the same is set out by me, by way of indication, from his instructions.' Whether Śaṅkara was the recepient of any *direct* instructions from Citrabhanu or not, the above-quoted statement is a pointer to the high regard which he had for that savant.

Besides the *Ekaviṁśati-praśnottara* noticed above, Citrabhānu is the author of an advanced astronomical manual entitled *Karaṇāmṛta*.[1]

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1. Ed. by V. Narayanan Namboodiri, with an anonymous commentary, *Trivandrum Skt. Series*, No. 240, (Trivandrum, 1975).

The work contains just over a hundred and thirty verses, in four chapters devoted, respectively, to the computation of the planets, gnomonic shadow and allied matters, the eclipses, and astronomical corrections for observation. Citrabhānu's reverence for Nīlakaṇṭha is indicated in the very first verse of the work, which reads :

प्रणम्य भास्वद्विघ्नेशवाग्विष्णुपरमेश्वरान् ।
ग्रहान् गुरूंश्च गार्ग्यादीन् करिष्ये करणामृतम् ॥ १.१ ॥

An anonymous commentary available on the work[1] explains the expression *gārgyādīn*, occurring in the above verse, as 'teachers like Gārgya-kerala-Nīlakaṇṭha.' The date of completion of the *Karaṇāmṛta* is given in the concluding verse of that work which reads :

'बुद्धघोन्मध्योद्धृतं यत्नात्' तन्त्राब्धेश्चित्रभानुना ।
तदेतत् 'कालतत्त्वज्ञा' गृह्णन्तु करणामृतम् ॥ ४.३४ ॥

The commentary explains : ग्रथ च 'बुद्धघोन्मध्योद्धृतं यत्नात्' (16,91,513) इत्यनेन ग्रन्थनिर्माणकालाहर्गणो दर्शितः । 'कालतत्त्वज्ञा' (4631) इत्यनेन तदानीन्तनः कल्यब्दः । इति सर्वं शिवम् ।

The Kali date and year given above fall in A.D. 1530-31. Citrabhānu is also a good connossieur of literature as exemplified by his erudite commentary called *Śabdārthdīpikā* on the *Kirātārjunīya* of Bhāravi.[2]

5. *Subrahmaṇya* (*c.* 1450-1550)

Another scholar of eminence whom Śaṅkara refers to with great respect is Subrahmaṇya mentioned in an introductory verse to his *Pañca-bodha-vyākhyā* which reads as follows :

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1. In the Introduction to the edition of the work, the commentary is attributed to the *TS* Commentator Śaṅkara but without any evidence being offered.

2. Ed. by T. Ganapati Sastri, Trivandrum, 1918, (*Trivandrum Skt. Series*, No. 63). The commentary, which is highly scholarly, extends only to the first three cantos of the poem.

शक्त्या शश्वन्निखिलसुमनस्संहृतिस्तद्विपक्षं
जित्वा सद्यो निजनिजपदे स्थापिता यस्य भाति ।
अक्षोभ्यः सन् निखिलजगतां वन्द्यपादः सुशीलः
सुब्रह्मण्यः स जयतितमां नीलकण्ठावलम्बी ॥ ८ ॥

It cannot be ascertained whether Subrahmaṇya was an astronomer, but Śaṅkara's high regard for both his scholarship and personal qualities is very much apparent in the verse quoted above. The reference by Śaṅkara of Subrahmaṇya's rapport with Nīlakaṇṭha (*Cf. Nīlakaṇṭhāvalambī*), is fully corroborated by Nīlakaṇṭha himself when he describes himself as 'a friend of Subrahmaṇya' (*Subrahmaṇya-sahṛdayena*) (p. xxiv, above). A post-colophonic statement in a manuscript of this work reads *Śrī-Subrahmaṇyāya namaḥ* (see above, p. lx), which also is, possibly, a reference to the said Subrahmaṇya.

9.3. Date of Śaṅkara (A.D. 1500-60)

The date of Śaṅkara can be fixed within reliable limits on the basis of the chronograms contained in his works. He gives the date of completion of his *Pañcabodha-vyākhyā* in the concluding verse of that work (see above, p. lx) through the Kali chronogram *prājñalokoddhṛtaṁ yatnād* (16,91,302), which falls in A.D. 1529. In his *Kriyākramakarī* occurs a problem for the calculation of Kali days, whose solution is 16,92,972, a date occurring in A.D. 1534. In his *Karaṇasāra*, Śankara gives the *khaṇḍadina*, the day for the commencement of calculations according to that work, as *anūnajñānasādhya* (17,00,000), occurring in the year A.D. 1554. The date of the last work he wrote, *viz.*, the *Laghuvivṛti* on the *TS*, is said to be Kollam year 971 (A.D. 1556)[1]. The above dates refer to a period of literary activity from A.D. 1529 to 1556. One would be justified, on the above basis, in fixing Śaṅkara's date as *c.* A.D. 1500-60.

10. CONTENTS OF THE YUKTIDĪPIKĀ

1. Notable exposition of theories and rationales

While even a cursory glance of *Yuktidīpikā* would give an idea of the extent and the variety of the topics dealt with in it, a closer

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1. Ulloor, *Kerala Sāhitya Charitram*, vol. II, (Trivandrum, 1954), pp. 273-75.

examination would reveal the depth of treatment and the logical approach adopted by the author in explaining astronomical theories and mathematical rationale. The exposition which is couched in simple, racy *anuṣṭup* verses makes his treatment all the more effective. As mentioned earlier in this Introduction, (see above, pp. xlv-xlvi), *Yuktidīpikā* introduces and discusses a large number of topics which are not actually stated in the textual verses of the *TS*, but which are useful for their correct understanding and proper appreciation, besides giving the rationale of the enunciations of the text. From among these, special attention might be drawn to the more important topics which are noticed below.

1. *Approach to astronomical studies*

Touching upon the invocation in the *Tantrasaṅgraha*, the commentary specifies the purpose of astronomical computation, the determinants of time, the aim of the discipline and the proper approach to the study of the science (pp. 1-3).

2. *Measurement of time*

Speaking of time measures (*TS*, I. 2-13), the commentary elaborates upon the rotation of the celestial sphere (pp. 4-5), the civil and sidereal days, and lunar measure of time (pp. 5-6), intercalary and lunar months (pp. 6-8) and the general nature of time measures (p. 8).

3. *Planetary revolutions*

Apropos the enumeration of the number of revolutions of the planets per aeon (*yuga*) (*TS* I. 14-22), the commentary speaks of the theory of *yugas* (pp. 11-12), intercalation (pp. 12-14), verification of aeonic revolutions by means of planetary conjunctions and by inference (pp. 14-18) and the revolution of the planets in circular orbits (pp. 18-19).

4. *Mathematical operations*

In three verses and a half (1. 23-26a), the *TS* enunciates a method for the calculation of the current Kali day. Since the said calculation involves mathematical operations, the commentary takes the occasion to set out the theory and practice of the different mathematical operations, including the square and cube and the roots thereof, zero, simple, associated and dissociated fractions, etc., stating also the

rationale of the methodology of the derivations of each (pp. 19-47). An interesting depiction herein is the theory of numbers (pp. 24-30).

5 *Rule of three and Pulverisation*

Two verses of the *TS* (I. 26b-28a), giving the method of computing the Mean planets, spark off, at the hands of the commentator, a twenty-page exposition (pp. 48-67) on the rule of three and the application of the rule in the determination of the current Kali day, Mean planets and Pulverisation (*Kuṭṭaka*), with the rationale underlying each of these calculations. It is of interest to note that Nīlakaṇṭha had adopted, for ease in calculation, the 'reduced' (*apavartita*) *yuga* of 576 (*tatsama*) years with the corresponding number of days 2,10,389 (*dhījagannūpura*) and gives the zero-corrections of planets at the beginning of the ninth 'reduced' *yuga* (= A.D. 1507-8) which is contemporaneous to his own times (A.D. 1444-1545) (*Cf.*, *TS* I. 35-39). The commentator gives the *Kuṭṭaka*-calculations relating to the same (pp. 63-67). The rationale of reduced multipliers and divisors in calculations with huge numbers is also explained later on (pp. 75-77).

6. *Situation of the Earth*

Under *TS* I. 28b-34, on the 'correction for longitude' (*deśāntara-saṁskāra*), the commentary dwells at length (pp. 68-73) with the position of the Earth as suspended in the atmosphere, gravitational pull, longitudinal difference of time and allied topics.

7. *The Circle*

Commencing the *Sphuṭaprakaraṇa* (ch. II), the text defines the circle, and sine and cosine (II. 1). The commentator takes the occasion to provide a 27-page exposition (pp. 78-104) of the entire gamut of mathematical conceptions thereof and the rationale involved therein. In respect of the circle, he first takes up the construction of a circle of diameter equal to the side of a given square and the computation of its circumference (pp. 80-88). Later, in the same context, he follows this up with the rationale on the derivation of the circumference of a circle in terms of its diameter and mentions several formulae involving the summation of infinite series and implying highly accurate approximations of the value of π (pp. 101-3).

8. *Summation of Series*

In as much as the formulae referred to above involves an understanding of the summation of series, the commentator deals elaborately with the rationales and formulae relating to the series (pp. 88-94). The series dealt with include the summation of natural numbers, squares, cubes and the sum of a summation of an infinite series.

9. *Rsine and Arc*

Since the computation of the True planets involves Rsines and arcs of circles (*TS*, II. 2-21a), the commentary, in its turn, sets out the conceptions thereof and the rationale involved. Among the topics dealt with here are the mathematical derivation of Rsines, Arcs, the accurate determination of the 24 ordained Rsines (*paṭhita-jyās*), sectional Rsines and Rsine differences, the summation of Rsines and Rsine differences, and the accurate computation of the Rsine at any desired point (pp. 105-12).

It has to be noted here that the formulae mentioned by the commentator above as also those similarly mentioned by him later in his commentary, are not all his own, but belonged to the tradition which he inherited. Some of these have been specifically stated by Nīlakaṇṭha and others to have been enunciated by an earlier astronomer Mādhava of Saṅgama-grāma (A.D. 1340-1425) who was known by the honorific title *Golavid.*

The rationale of certain methodologies and formulae of Mādhava, who is mentioned by name, are also set out here. These include the computation of the arc of a given Rsine, the derivation of the phrases *vidvān* etc. to be used for the accurate computation of any desired Rsine and Rversed sine, and the *jīve paraspara-nyāya* for calculating the Rsine of the sum or difference of two angles (pp. 112-26). In the same context, the properties of cyclic quadrilaterals are also taken up and discussed (pp. 127-43) and a formula derived for the surface area of a sphere (pp. 146-51).

10. *Ascensional differences*

In connection with the computation of True Sun, the *TS* refers to Ascensional difference (*Cara*). The commentary gives, in this context, a detailed treatment of the rationale of the derivation of *cara* and the application thereof to the Sun and the different planets (pp. 153-58).

11. *Theory of Epicycles*

The computation of True planets involves the conception of epicycles. The commentator gives in this context, the Hindu epicyclic theory and analyses in detail the calculation of true planets (pp. 159-85). The *Golasāra* of Nīlakaṇṭha comes in for substantial citation. Special mention deserves to be made, in this connection, to the commentator's explanation of planetary motion, daily motion of the Sun and the Moon, and the specialities in the computation of Mercury and Venus.

12. *Celestial globe : Different conceptions*

Chapter Three of *Tantrasaṅgraha* deals with computations relating to the gnomonic shadow and allied matters. Introducing the chapter, the commentary sets out the three conceptions of the celestial globe as *Bhūgola* (Earth sphere), *Vāyugola* (Atmospheric sphere) and *Rāśigola* (Zodiacal sphere) (pp. 186-88), and the rationale of determining the directions accurately (pp. 188-90).

13. *Rising of the signs*

In the *TS*, the method of calculating the Rising of the signs (*Lagna*) is enumerated in III. 14-16a, in which context, the *Yuktidīpikā* explains the cause for the difference of the rising of the signs at different places and gives the rationale for its derivation at any desired place (pp. 194-97).

14. *Gnomon and the Great Gnomon*

Several propositions are enunciated in the *TS* relating to the 12-inch Gnomon (*Dvādaśāṅgulaśaṅku*), Great gnomon (*Mahāśaṅku*), Great gnomon when the Sun is at the Prime vertical (*Samaśaṅku*) and Midday shadow (*Madhyāhnacchāya*), (*TS* III. 16b-59), the rationale of all of which are provided for in the *Yuktidīpikā* (pp. 197-218). Some of the interesting topics elaborated here are : (1) the theory of the Precession of the equinoxes (*Ayanacalana*) (pp. 204-7), (2) determination of the directions from the shadow (pp. 209-13), and (3) graphical representation of the Shadow circle (pp. 213-14).

15. *The Ten Shadow problems* (*Daśapraśna*)

Ch. III, verses 60-62a of the *Tantrasaṅgraha* mention that from among the five items, *viz.*, Great gnomon (*Mahāśaṅku*), Parallax in latitude (*Nata*), Declination (*Krānti*), Amplitude at rising (*Digagrā*) and

Latitude (*Akṣa*), if three are known, the other two can be derived in ten ways. The *TS* also enunciates the methods for such derivations (III. 62b-87). The *Yuktidīpikā* takes up these ten Shadow problems and discusses in detail the rationale of their solution, one by one (pp. 219-36).

16. *Great shadow (Mahācchāyā) in any direction*

In III. 88-91, the *TS* mentions a formula for *Iṣṭadikchāyā*, being the *Mahācchāyā* in any direction. The commentary sets out the derivation thereof from the data given, *viz.*, Declination, Latitude and Amplitude at rising (pp. 237-39).

17. *Rising point of the Ecliptic*

The last topic dealt with in chapter Three of the *TS* relates to the Rising point of the ecliptic (*Lagna*) and allied computations. The *Yuktidīpikā* takes the occasion to delve upon the astronomical situation at the Orient ecliptic, the rationale of deriving the ecliptic-zenith distance (*Dṛk-kṣepa*) and also the rising, setting and meridian points of the ecliptic (*Udaya-*, *Asta-* and *Madhya-lagna*) (pp. 241-50).

18. *Lunar eclipse*

Chapter Four of the *TS* is concerned with eclipses, particularly that of the Moon. From among the rationales given in the *Yuktidīpikā* in this connection, attention might be directed to : The celestial situation at an eclipse (pp. 255-56), (2) the detailed elucidation of the factors of the eclipse and the computation thereof (pp. 259-75), (3) the rationale of *Valana* (deflection due to latitude and declination) (pp. 275-77) and (4) the graphical representation of the eclipse (pp. 277-79).

2. Extent of Yuktidīpikā

1. *Portion now available*

The known manuscripts of *Yuktidīpikā* do not extend beyond ch. IV of the work. One of the manuscripts carries also a post-colophonic statement to the effect that the work is complete. But this statement cannot be taken as confirmative, since, as shown earlier, (see above, p. xx), all these manuscripts are derived from a common archetype which should have contained only these four chapters. Neither can the adaptation of verses from the *Yuktidīpikā* in the *Kriyākramakarī*

(see above, pp. xlvii-viii) be of help, for the subject matter of *Līlāvatī*, of which *Kriyā.* is a commentary, is limited to mathematics and one could expect herein *YD* verses only from chs. I to III of the *TS* which are relevant also to mathematics, and not from chs. IV to VIII.

2. *Evidence for YD on the entire work*

However, there are evidences to show that Śaṅkara had continued the commentary to completion. In the *Yuktidīpikā*, when a topic which has been discussed in detail at one place is mentioned also at another place, attention is generally drawn to the said detailed treatment. Thus, the detailed treatment of the epicycles in Ch. II, com. verses 865-95, (pp. 159-61), is referred to in an earlier context in the words :

स्पष्टीकरिष्यते चैतदुपरि स्फुटकर्मणि ॥ I. com. 147 ॥ (p. 16)

Referring to *Lambana* (parallax in longitude) to be elaborated in ch. V, where the Solar eclipse is dealt with, he says in ch. IV :

तदेतद् ग्रहणेऽर्कस्य पश्चात् स्पष्टीकरिष्यते ॥ IV. com. 128 ॥ (p. 267)

In the same manner, while speaking about the computation of Moon's orb in ch. IV, the Śaṅkara says :

स्पष्टीकरिष्यते चैतदूर्ध्वं शृङ्गोन्नतौ विधोः ॥ IV. com. 38 ॥ (p. 256)

The reference is to the last chapter, *viz.*, *Śṛṅgonnati-Prakaraṇa*, of the *Tantrasaṅgraha*, indicating, at least, that Śaṅkara intended to comment up to the last chapter. Definitive proof in the matter is provided by Śaṅkara in his concise commentary *Laghuvivṛti* on *TS* VII. 4-6 (p. 322 below), where the corresponding portion of the larger commentary *Yukti-dīpika* is referred to in the passage ; अत्र विक्षेपस्वरूपं प्रति यद् वक्तव्यं तन्मयैव एतद्व्याख्यायां युक्तिदीपिकायां प्रपञ्चितम् इति तत एव अवधार्यम्, proving that the *Yuktidīpikā* extended to ch VII. It is to be hoped that further searches would unearth complete manuscripts of *Yuktidīpikā* covering all the eight chapters.

3. Authorities cited in the Yuktidīpikā

The *Yuktidīpikā* being a repository of the mathematical and astronomical tradition prevalent in Kerala about A.D. 1500, it is but natural that it should digest the contributions of several earlier authorities besides presenting the author's own views. Indeed, a few works and

authors have been named in the *YD*. These include the *Āryabhaṭīya*, *Sūryasiddhānta* and *Siddhāntaśiromaṇi* among authorities of all-India prevalence, and Saṅgamagrāma-Mādhava, Nīlakaṇṭha (*Golasāra*, *Siddhāntadarpaṇa*, etc.) and Śaṅkara's primary source, '*Parakroḍāvāsa-dvijavara*' Jyeṣṭhadeva. There are also a number of passages which are apparently quotations given anonymously, some of which could be identified and their references indicated in the edition below.

General views are introduced by such expressions as *golavittamaiḥ*, *tantrāntare*, *kaiścit*, etc. Śaṅkara refers also to his *Ācārya* or *Guru* and some of the passages could be traced to Nīlakaṇṭha's works. In a passage of this type, speaking about the determination of the number of revolutions in a *yuga*, he says :

> प्रत्यक्षसिद्धात् सम्बन्धात् कालयुक्त्योरितीदृशात् ।
> इयत्ता भगणादीनां युगादिष्वनुमीयते ॥
> आचार्यैस्तदिदं ज्योतिर्मीमांसायां प्रदर्शितम् ॥ I. com. 148-49 ॥ (p. 16)

If the *Ācārya* mentioned is Nīlakaṇṭha and a work is referred to, both of which are quite likely, we have, here, a reference to a hitherto unknown and important work of Nīlakaṇṭha entitled *Jyotirmīmāṁsā* ('Investigations into astronomical theories'). Judged from its title and the context in which it is cited, this treatise should have contained an instructive exposition of current astronomical conceptions, some of which Śaṅkara has set out in his commentary verses, I. 123-79 (pp. 14-19).

11. CONTENTS OF LAGHUVIVṚTI

The commentary *Laghuvivṛti* of Śaṅkara, his 'last' work, 'composed with care for Āzhvāñceri' (See above, pp. 1, lx) is, as its name implies, 'concise' (*laghu*) and primarily concerned with setting out the 'collocation of computations' (*kriyā-kalāpa*) enunciated in the *Tantrasaṅgraha*. But for an instace or two, (see, for *e.g.*, *TSS* edn., p. 69), there are no poetic elaborations which characterise the *Yuktidīpikā*. However, several authorities are cited with or without the indication of their sources. Among the former are *Āryabhaṭa*, *Sūryasiddhānta*, *Brahmasiddhānta*, Bhāskara, Śrīpati, Nīlakaṇṭha and Śaṅkara's own earlier commentary *Yuktidīpikā*. It deserves to be noted here that in respect of the 'Ten Shadow problems' (*Daśapraśna*), enunciated in the *Tantrasaṅgraha*, III. 60-87, Śaṅkara supplies 39 illustrative problems and also

one problem relating to *Iṣṭadikcchāyā*. Most of these problems are also worked out by him (see *TSS* edn., pp. 66-91).

12. ACKNOWLEDGEMENTS

Most of the manuscripts of the *Tantrasaṅgraha* and its two commentaries used for the present edition are preserved in the Kerala University Oriental Research Institute and Mss. Library, which is the biggest repository of Kerala manuscripts. I am beholden to the Director Dr. K. Raghavan Pillai, and other members of that institution, especially Shri M. Madhavan Unni, Research Officer, and Shri N. Sundaram, Scribe, for enabling me to make use of the wealth of material available there. I could make use of one manuscript each from the Vishveshvaranand Library, Hoshiarpur, the Govt. Sanskrit College Library, Trippunithura, and the Govt. Oriental Mss. Library, Madras, for enabling which I am highly thankful to the authorities of these institutions.

तन्त्रसंग्रहः

युक्तिदीपिका-लघुविवृत्याख्य-व्याख्याद्वयोपेतः

नीलकण्ठसोमयाजिविरचितः

तन्त्रसंग्रहः

अथ प्रथमोऽध्यायः

[मङ्गलाचरणम्]

हे विष्णो निहितं कृत्स्नं जगत् त्वय्येव कारणे ।
ज्योतिषां ज्योतिषे तस्मै नमो नारायणाय ते ॥ १ ॥

तन्त्रसंग्रहस्य पद्यव्याख्या*

अथ प्रथमोऽध्यायः

[मङ्गलाचरणम्]

कारणभूतो जगतां वारणवक्त्रः स विजयतां देवः ।
भक्तजनप्रत्यूहप्रशमनपटुचरितसर्वस्वः ॥ १ ॥

करकमलकलितपुस्तकवराभयाक्षस्रजं[1] विशुद्धाङ्गीम् ।
मौलिलसच्चन्द्रकलां त्रिलोचनां[2] भारतीं वन्दे ॥ २ ॥

यत् तन्त्रसंग्रहं नाम पूर्वैः प्रकरणं कृतम् ।
हितायाल्पधियां तस्य पद्यैर्व्याख्या विलिख्यते ॥ ३ ॥

हे विष्णो इति (I. 1)[3]—

मृत्तिकायां यथा भाति कृत्स्नं कुम्भघटादिकम् ।
नारायणे तथा भाति जगदेतच्चराचरम् ॥ ४ ॥

जगत्कारणता तस्य निर्विवादा स्थिता ततः ।
ज्योतिष्ट्वं ज्योतिषां तस्य ज्ञेया भगवदुक्तितः ॥ ५ ॥

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*Com. Mss. used : A. R. No. 2505 of the GOML, Madras ; B. No. C-1375, C. No. 16932-B, and D. No. 586-E of the KUORIML, Trivandrum.

व्याख्या—1. C. D. वराभयात्मप्रजं (C. °बृजं) 2. C. Om. त्रिलोचनां
3. C. adds इति मूलश्लो॰

"यदादित्यगतं तेजो जगद् भासयतेऽखिलम् ।
यच्चन्द्रमसि यच्चाग्नौ तत्तेजो विद्धि मामकम् ॥" ६ ॥
(भगवद्गीता, १५. २)

इति यत् किल गीतायामुक्तं भगवता स्वयम् ।
नारायणाख्यया नाम्न:[1] सहस्रमुपलक्षितम् ॥ ७ ॥

ततो नामसहस्रेण तस्योक्त्या कीर्त्यमानता ।
कायवाङ्मनसानां य: परमेश्वरगोचर: ॥ ८ ॥

प्रह्वीभावो नमस्कारशब्दार्थ: सर्वविन्मत: ।
सर्वानुग्राहके विश्वोत्कृष्टे युक्त: स तादृश: ॥ ९ ॥

अतस्तादृङ्नमस्कारात् सिद्धयेत् सर्वं यथेप्सितम् ।
शास्त्राणां मङ्गलादीनां प्रथमानत्वमिष्यते[2] ।
तथा[3] प्रकृष्टव्याख्यातृश्रोतृलाभश्च जायते ॥ १० ॥

[गणितप्रयोजनम्]

श्रुतिचोदितकर्माङ्गभूतकालावबोधिन: ।
शास्त्रस्यास्य तदङ्गस्य कालज्ञानं प्रयोजनम् ॥ ११ ॥

[कालपरिच्छेद:]

कालो यत: परिच्छेद्यो ज्योतिश्चक्रे ग्रहभ्रमात् ।
भचक्रसप्तविंशांशै: चन्द्रचारा[4]द्वजादित: ॥ १२ ॥

अश्विन्यादीनि भानि स्युस्तत्र तत्प्रमितार्कत:[5] ।
त्रिंशांशे चन्द्रचारेण तिथय: प्रतिपन्मुखा: ॥ १३ ॥

तत्तदंशेषु तद्बिम्बघनमध्यप्रवेशत: ।
तन्निर्गमाच्च नक्षत्रतिथ्याद्यन्तौ प्रकीर्तितौ ॥ १४ ॥

एवमन्येऽपि[6] कालांशा वेद्या भ्रमवशात् तयो: ।
स्वदेशे प्रतिपच्छेदो भग्रहोद्गमनादिना ॥ १५ ॥

व्याख्या—1. B. D. नाम
2. B. प्रथमं नत्वमिष्यते
3. D. यथा
4. D. om. चारा
5. D. प्रतिमार्कत:
6. C. ग्रहमन्येऽपि

व्यवस्थिता गतिस्तेषां निजवृत्तेषु सर्वदा ।
वृत्तान्तरेण भ्रमिता भिन्नरूपानुभूयते ॥ १६ ॥

भूयोदर्शनतस्तर्कानु[1]विद्धात् तद्विनिश्चयः ।
बुधैरीषत्करो गोलयुक्तिविद्भिरसंशयम् ॥ १७ ॥

गणिताधीनविज्ञाना भगोलप्रमिता गतिः ।
त्रैराशिकोपपत्त्याथ ग्रहाणां क्षेत्रकल्पनात् ॥ १८ ॥

[शास्त्रप्रयोजनम्]

उपायभूतं गणितं शास्त्रेण प्रतिपाद्यते ।
गणिते प्रतिपाद्येत शास्त्रे[2] च प्रतिपादके ॥ १९ ॥

सम्बन्धोऽप्यनयोर्वेद्यः स तथाभावलक्षणः ।
गणितग्रहभुक्त्योरप्युपायोपेयलक्षणः ॥ २० ॥

ग्रहभुक्तिपरिच्छिन्नः[3] कालभेदो भवेद् यतः ।
श्रौतकालपरिच्छेदः शास्त्रस्यास्य प्रयोजनम् ॥ २१ ॥

[शास्त्राध्ययनम्]

"अवश्यमेतच्छ्रोतव्यमध्येयं च द्विजातिभिः ।
वेदार्थस्य विचारोऽत्र यतः साङ्गो विधीयते ॥ २२ ॥

रहस्यमेतद्देवानां न देयं यस्य कस्यचित् ।
सुपरीक्षितशिष्याय दातव्यं ज्ञानमुत्तमम्" ॥ २३ ॥

इत्येतत् सूर्यसिद्धान्तवचो नात्र विरुध्यते ।
गुणिनामेव नान्येषां विप्राणामधिकारतः ॥ २४ ॥
[4]तत्र शिष्यपरीक्षार्थं गुरुरेव नियुज्यते ।
शिष्यस्यास्य नियोज्यत्वात् तदुक्तिर्न विरुध्यते ॥ २५ ॥
प्रतिपत्तुर्हि[5] दोषेण शास्त्रानर्थक्यकीर्तनात् ।
तादृशामिह सर्वत्र प्रसिद्धाऽनधिकारिता ॥ २६ ॥ इति ॥

व्याख्या—1. A. दर्शनतस्त्वर्कानु 2. D. प्रतिपाद्ये तच्छास्त्रे
3. A. D. परिच्छिन्नं
4. D. About 4 cm. of the recto of the folio broken off, causing the loss of three letters each in the five lines in the folio. 5. C. D. प्रतिपत्तिर्हि (D. °त्तर्हि)

[सावननक्षत्रदिनमानम्]

रवेः प्रत्यग्भ्रमं प्राहुः सावनाख्यं दिनं नृणाम् ।
आर्क्षमृक्षभ्रमं तद्वत्, ज्योतिषां प्रेरको मरुत् ॥ २ ॥

भ्रमणं पूर्यते तस्य नाडीषष्ट्या मुहुर्मुहुः ।
विनाडिकापि षष्ट्यंशो नाड्या गुर्वक्षरं ततः[1] ॥ ३ ॥

प्राणो गुर्वक्षराणां स्याद् दशकं चक्रपर्यये ।
खखषड्घनतुल्यास्ते वायुः समजवो यतः ॥ ४ ॥

[कालस्वरूपम्]

रवेः प्रत्यग्भ्रममित्यादि[1] (I. 2-13)—

[भगोलभ्रमणम्]

प्रत्यहं भ्रमणं प्रत्यङ्मुखं दृष्टं द्युचारिणाम् ।
परतोऽथ स्वतस्तेषां प्राङ्मुखं चानुमीयते ॥ २७ ॥

भगोलं भ्रामयेन्नित्यं प्रत्यक् प्रवहमारुतः[2] ।
तद्वशादेव तत्स्थानि ग्रहर्क्षाणि मुहुर्मुहुः ॥ २८ ॥

अतः प्रत्यङ्मुखं तेषां भ्रमणं परतो मतम् ।
ज्योतिश्चक्रे यदा येन नक्षत्रेण युतो ग्रहः ॥ २९ ॥

कालान्तरे पुनस्तस्मात् संयुक्तोऽन्येन दृश्यते ।
नक्षत्राणि स्थिराण्येव स्वप्रदेशेषु तु स्वतः ॥ ३० ॥

न कदाचित् क्वचिद्यान्ति स्वदेशाद् गत्यभावतः ।
प्रदेशान्तरसंयोगो नोपपन्नोऽप्यगच्छतः ॥ ३१ ॥

ततः प्रतीच्यनक्षत्रात् प्राच्यनक्षत्रयोगतः ।
प्रत्यहं प्राङ्मुखी भुक्तिर्ग्रहाणामनुमीयते ॥ ३२ ॥

भिन्ना प्रतिक्षणं चासौ भगोलावयवैर्मिता ।
भगोलमध्यवर्तिन्यां भूमौ द्रष्टुरवस्थितेः[3] ॥ ३३ ॥

मूलम्— 1. B. omits the line.

व्याख्या—1. C. adds 'मूलश्लो०' 2. A. मारुतम्

3. A. स्थितेः; C. रपि स्थितेः

[चान्द्रमासः]

पूर्वपक्षः शशाङ्कस्य विप्रकर्षो रवेः स्मृतः ।
सन्निकर्षोऽपरः पक्षः सितवृद्धिक्षयौ ययोः ॥ ५ ॥

ततोऽन्यफलभिन्नस्वकेन्द्रे वृत्ते च तद्गतेः[1] ।
प्रत्यहं भिन्नरूपेण प्राग्भ्रमेण समन्वितम् ॥ ३४ ॥

प्रत्यङ्मुखं तद्भ्रमणं प्रत्यावृत्ति विभिद्यते ॥ ३५ ॥

[सावन-नाक्षत्र-दिनमानम्]

रवेः प्रत्यग्भ्रमेणात्र प्रमितं सावनं दिनम् ।
दिनव्यक्तिषु सर्वासु भिन्नकालतया मिथः ॥ ३६ ॥

दुष्करं चानुपातेन मध्यभुक्ति[2]रहर्गणात् ।
तुल्यकालैस्तु[3] नाक्षत्रैर्यद्येषा सुकरा भवेत् ॥ ३७ ॥

तदर्थमिह नाक्षत्र[4]दिनमानं प्रदर्शितम् ।
[5]नन्वर्कभगणैर्युक्तादर्कसावनवासरात् ॥ ३८ ॥

दिनान्यार्क्षाणि तेभ्योऽर्कभगणास्तैश्च सावनैः ।
दिनान्यार्क्षाणि कल्प्यानीत्यन्योन्याश्रयता भवेत् ॥ ३९ ॥

नैवं गतार्कभगणहीनार्क्ष[6]दिनसञ्चयः ।
यातसावनतुल्योऽत्र कल्पनीयोऽपवर्तनात् ॥ ४० ॥

अतो युगार्क्ष[7]दिवसा युगार्कभगणोनिताः[8] ।
युगसावनतुल्यास्ते कल्प्या येन सजातिता ।
ग्रहाणां मध्यभुक्तिर्वा कर्तव्या मध्यसावनैः ॥ ४१ ॥

[सौर-चान्द्र-मानम्]

अतीतकालसाध्यास्ते[9] कालो नानाविधश्च सः ।
तथाहि वत्सरः सौरो मासश्चान्द्रोऽथ सावनम् ॥ ४२ ॥

व्याख्या—1. A. गते ; C. गतौ
2. D. बुद्धिः for भुक्तिः
3. D. कालेषु
4. D. नक्षत्र
5. A. सम्पर्क; B. न त्वर्क
6. B. हीनार्क
7. A. B. युगार्क
8. A. B. D. भगणोनितः
9. A. साम्यास्ते; D. Broken.

मासस्ताभ्यां [1]मतश्चान्द्रस्त्रिंशत्तिथ्यात्मकः स च ।

[सौरमासः]

सौरोऽब्दो[2] भास्करस्यैव ज्योतिश्चक्रपरिभ्रमः ॥ ६ ॥

मासस्तु राशिभोगः[3] स्यादयने चापि तद्गती[4] ।

[अधिमासः]

त्रयोदशस्य चैत्रादिद्वादशानामियं भिदा ॥ ७ ॥

दिनमेतैस्त्रिभिः साध्यः सावनो द्युगणो गतः ।
अतीतानां च गणना तेषां नातीव दुष्करा ॥ ४३ ॥

तथाहि मासश्चान्द्रोऽसौ प्रत्यक्षेणोपलभ्यते ।
चित्रानक्षत्रयुक्तस्य पूर्णेन्दोर्निशि दर्शनात् ॥ ४४ ॥

चैत्रमासो विशाखाद्यैर्वैशाखाद्यास्तथा युतैः ।
मासाश्चैत्रादयश्चान्द्राः सौरैर्मेषादिभिः समाः[1] ॥ ४५ ॥

[अधिमासः]

यस्त्वलक्ष्मा[2] बहिष्कार्यः स चान्द्रोऽसौ त्रयोदश ।
संबद्धाः स्वोचितैः सौरैश्चान्द्राश्चैत्रादयस्ततः ॥ ४६ ॥

न्यूनत्वात् सर्वचान्द्राणां सौरेभ्यो विप्रकृष्टताम्[3] ।
त्रयोदशं परिहरेद् योग्यः सौरान्वयप्रदः ॥ ४७ ॥

अतो नियतसङ्क्रान्तिगर्भत्वं लक्षणं कृतम् ।
चैत्रादीनामसङ्क्रान्तिस्त्वधिमासोऽपि लक्षितः ॥ ४८ ॥

मेषाद्येकैकसङ्क्रान्तिगर्भाश्चैत्रादयस्ततः ।
असङ्क्रमोऽधिमासोऽपि स्यादंहस्पत्यबाधितः ॥ ४९ ॥

[संसर्पांहस्पती]

कवलीकृतसङ्क्रान्तियुगलोंऽहस्पतिर्यदा ।
तदा तत्पार्श्वयोः स्यातामुभौ चान्द्रावसङ्क्रमौ ॥ ५० ॥

मूलम्— 1. B. अतः for मतः 2. B. सौराब्दो
3. A. राशिभागः 4. A. तद्गतिः

व्याख्या—1. C. तदा for समाः 2. A. यस्त्वलक्ष्या
3. C. सौरेभ्योऽतिप्रकृष्टताम्

मेषाद्येकैकराशिस्फुटगतिदिनकृत्सङ्क्रमैकैकगर्भा-
श्चान्द्राश्चैत्रादिमासा इह न यदुदरे सङ्क्रमः सोऽधिमासः ।
संसर्पः स्यात्, स चांहस्पतिरुपरि यदि ग्रस्तसङ्क्रान्तियुग्म-
स्तौ चाब्दत्वेऽङ्गभूतौ सह सुचिरभवौ सोऽधिमासोऽत्र पश्चात् ॥८॥

तयोः पूर्वोऽत्र[1] संसर्प उत्तरस्त्वधिमासकः ।
संसर्पांहस्पती[2] वर्षत्वेऽङ्ग[3]भूतौ, न चाधिकः ॥ ५१ ॥

तथाहि संसर्पाख्योऽयं चैत्रादिषु यदूर्ध्वगः ।
चैत्राद्यनुप्रविष्टोऽसौ ऊर्ध्वसङ्क्रमगर्भवत् ॥ ५२ ॥

तदूर्ध्वसङ्क्रमयुतास्ततो[4]ऽप्यूर्ध्वोर्ध्ववत् स्थिताः ।
ततः संसर्पतो[5] यावदंहस्पति भवन्ति ये ॥ ५३ ॥

असङ्क्रान्त्यन्यसंक्रान्तिसंक्रान्तिद्वितयाश्रिताः ।
तेषां चैत्राविशेषत्व[6]मब्दत्वेऽङ्गतया स्थितम् ॥ ५४ ॥

असङ्क्रमस्तूर्ध्वगतो नोपयाति तदङ्गताम्[7] ।
यदि वा सोर्ध्वमासेन संयुक्तोऽसौ त्रयोदशः ॥ ५५ ॥

दिनषष्ट्यात्मकं मासं तद्युक्तं व्यवहारयेत् ।
त्रयोदशभिरेवाब्दमासैर्यद्वा तदन्वितम् ॥ ५६ ॥

[चान्द्रमासः]

अर्केन्द्वोर्भिन्नकक्ष्यावस्थितयोरपि सर्वदा ।
एकस्यामिव कक्ष्यायां लक्ष्ययो[8]रर्कतो विधोः ॥ ५७ ॥

वर्धते विप्रकर्षेण शौक्ल्यं[9] कार्ष्ण्यं च सन्निधेः ।
शुक्लकृष्णौ ततः पक्षौ स्यातां पूर्वापरौ च तौ ॥ ५८ ॥

पक्षद्वयसमारब्धश्चान्द्रमासः प्रकीर्तितः ।
चन्द्रबिम्बविकाराणां सर्वेषां तत्र सम्भवात्[10] ॥ ५९ ॥

व्याख्या—1. D. पूर्वत्र
2. A. स्पतिः
3. A. स्पतिर्वर्षत्वेङ्ग; D. वर्षत्वाङ्ग
4. D. युता ततो
5. A. संसर्पको; B. संसर्पयो
6. C. मेषात् चैत्रादि; D. om. शेषत्व
7. A. तदङ्गतः
8. C. रक्षयो
9. D. om. शौक्ल्यं
10. A. सम्भवेत्

अर्केन्द्वोः स्फुटतः[1] सिद्धास्त्रयो मासा मलिम्लुचाः[2] ।
इति च ब्रह्मसिद्धान्ते मलमासास्त्रयः स्मृताः ॥ ९ ॥

द्वाभ्यां द्वाभ्यां वसन्तादिर्मध्वादिभ्यामृतुः स्मृतः ।
मध्वादिभिस्तपस्यान्तैर्वर्षं द्वादशभिः स्मृतम् ॥ १० ॥

त्रयोदशभिरप्येकं वर्षं स्यादधिमासके ।
स्वोत्तरेणाधिमासस्य सम्बन्धो मुनिभिः स्मृतः ॥ ११ ॥

भानुना लङ्घितो मासो ह्यनर्हः सर्वकर्मसु ।
षष्टिभिर्दिवसैर्मासः कथितो बादरायणैः ॥ १२ ॥

इति केषुचिदब्देषु सन्ति मासास्त्रयोदश ।
श्रूयते [3]चतुर्यागादिष्वयमेव[4] त्रयोदश ॥ १३ ॥

[वर्षमासदिनलक्षणानि]

अयनद्वयसंवेद्यः सौरः संवत्सरः स्फुटम् ।
अस्तंगते रवेर्बिम्बे चित्रानक्षत्रसंयुतात् ॥ ६० ॥

[1]पूर्णेन्द्वोरुदयाद् यद्वा चैत्रोऽब्दादिः प्रकीर्तितः[2] ।
यतःकुतश्चिन्नक्षत्राद् यद्वा राकेन्दुसंयुतात् ॥ ६२ ॥

रवेः प्रत्यग्भ्रमेणैव प्रमितं सावनं दिनम् ।
वर्षमासदिनात्मातः कालो ज्ञेयः स्वलक्षणैः ॥ ६३ ॥

[ग्रहपर्ययाः]

दिव्यं दिनमित्यादि[3] (I. 14-22)—

[संख्याविन्यासः]

ये[4] यत्संख्याः[5] प्रतीयन्ते पदार्था लोकशास्त्रयोः ।
तेषां संख्यावतां संख्याप्रतीत्यनुपपत्तितः ॥ ६४ ॥

मूलम्— 1. A. B. अर्केन्दुस्फुटतः 2. A. मलिम्लुचः
3. B. C 1. 2. 5. 6. यागेयं मास एव (B. यागेय)
4. A. om its the line haplographically.

व्याख्या—1. A. B. C. सूर्येन्द्वोः 2. B. C. D. प्रतीयताम्
3. C. adds: मूलश्लो० 4. A. यो
5. A. C. संख्योः

[दिव्यदिनादिः]

दिव्यं दिनं तु सौरोऽब्दः[1], पितॄणां मास ऐन्दवः ।
सर्वेषां वत्सरोऽह्नां स्यात् षष्ट्युत्तरशतत्रयम् ॥ १४ ॥

[ग्रहादीनां युगपर्ययाः]

दिव्याब्दानां सहस्राणि द्वादशैकं चतुर्युगम् ।
सूर्यस्य पर्ययास्तस्मादयुतघ्नरदार्णवाः ॥ १५ ॥

खाश्विदेवेषुसप्ताद्रिशराश्चेन्दोः, कुजस्य तु ।
वेदाङ्गाहिरसाङ्काश्विकरा, ज्ञस्य स्वपर्ययाः ॥ १६ ॥

नागवेदनभःसप्तरामाङ्कस्वरभूमयः ।
व्योमाष्टरूपवेदाङ्गपावकाश्च बृहस्पतेः ॥ १७ ॥

अष्टाङ्कदस्रनेत्राश्विखाद्रयो भृगुपर्ययाः ।
भास्कराङ्करसेन्द्राश्च शनेः, शश्युच्चपातयोः ॥ १८ ॥

मुख्यार्थबाधे संख्यैव कथ्यते गुणवृत्तितः ।
अर्थभूतादिभिस्तद्वत्संख्या छन्दोविधायिभिः ॥ ६५ ॥

संख्या प्रख्याप्यते शब्दैर्नभः शून्यार्थवाचकम् ॥ ६६ ॥

[ग्रहादीनां युगपर्ययाः]

तस्मात्—

खाश्विदेवेषुसप्ताद्रिशराश्चन्द्रस्य पर्ययाः ।
वेदाङ्गाहिरसाङ्काश्विकरा भूमिसुतस्य ते ॥ ६७ ॥

बुधस्य नागवेदाभ्रशैलाग्न्यङ्कस्वरेन्दवः ।
स्वकेन्द्राक्रान्त[1]मध्यार्ककक्ष्यावृत्तमितं तु तत् ॥ ६८ ॥

बुधभार्गवयोर्वृत्तं शीघ्रघनीचोच्चवृत्तताम् ।
याति तस्मिन्[2] स्वगत्यैव चरतो बुधशुक्रयोः ॥ ६९ ॥

मूलम्— 1. A. B. सौराब्दः

व्याख्या—1. A. B. D. स्वकेन्द्राक्रान्त　　2. A. कोऽस्मिन्; C. केऽस्मिन्

नेत्रार्काष्टाहिवेदाश्च खखरामरदाश्विनः ।

[युगे सावनदिवसादिः]

खखाक्षात्यष्टिगोसप्तस्वरेषुशशिनो युगे ॥ १९ ॥

सावना दिवसाश्चार्क्षा मार्ताण्डभगणाधिकाः ।
अधिमासाः खनेत्राग्निरामनन्देषुभूमयः ॥ २० ॥

अयुतघ्नाब्धिवस्वेकशरा मासा रवेः स्मृताः ।
खव्योमेन्दुयमाष्टाभ्रतत्त्वतुल्यास्तिथिक्षयाः ॥ २१ ॥

खखषण्णवगोनन्दनेत्रशून्यरसेन्दवः ।
तिथयः, चान्द्रमासाः स्युः सूर्येन्दुभगणान्तरम् ॥ २२ ॥

युगोत्थाः पर्ययास्त्वेते तत् स्वशब्देन वर्णितम् ।
व्योमाष्टरूपवेदाङ्कपावकाश्च बृहस्पतेः ॥ ७० ॥

अष्टाङ्कवसुनेत्राश्विखाद्रयो भृगुपर्ययाः ।
भास्कराङ्करसेन्द्राश्च शनेस्तु युगपर्ययाः ॥ ७१ ॥

शश्युच्चपर्यया नेत्रार्काष्टौ वेदा[1] युगोदिताः ।
पातस्य पर्ययास्तत्र खखरामरदाश्विनः ॥ ७२ ॥

[भूभ्रमणम्]

आर्क्षाः[2] खखेषुसप्ताग्निनेत्राश्व्यष्टेषुभूमयः ।
ऋक्षपर्ययतुल्यं च प्राङ्मुखं भ्रमणं भुवः ॥ ७३ ॥

[युगे सावनदिवसादिः]

रव्यादेरुदयाः स्वस्वभगणोनार्क्षपर्ययाः ।
खखाक्षात्यष्टिगोसप्तस्वरेषुशशिनो युगे ॥ ७४ ॥

सावना दिवसाश्चार्क्षा मार्तण्ड[3]भगणाधिकाः ।
द्वादशघ्नाश्च रव्यब्दा रविमासाः प्रकीर्तिताः ॥ ७५ ॥

अयुतघ्नाब्धिवस्वेकशरास्ते च युगोद्भवाः ।
चान्द्रा मासाश्च[4] सूर्येन्द्वोर्भगणान्तरतो युगे ॥ ७६ ॥

व्याख्या—1. A. नेत्राष्टार्कवेदा; B. C. नेत्रार्काष्टवेदा 2. A. भार्क्षं; B. भार्क्षाः
3. A. मार्तण्ड 4. C. चान्द्रमासाश्च

ते चात्र नेत्रहुतभुग्वेदाम्बुधिगुणेषवः ।
मासानां सौरचान्द्राणां विशेष[1]स्त्वधिमासकः ॥ ७७ ॥

युगोदिताः खनेत्राग्निरामनन्देषुभूमयः ।
चान्द्रसावनयोर्भेदा दिनयोरवमोद्भवः ॥ ७८ ॥

खव्योमेन्दुयमाष्टाभ्रतत्त्वतुल्यास्तिथिक्षयाः ।
खखषण्णवगोनन्दनेत्रशून्यरसेन्दवः ।
तिथयः स्युर्युगे चान्द्रमासास्त्रिशद्गुणास्तु ते ॥ ७९ ॥ इति ।

किञ्च—

[ग्रहयुगानि ग्रहसामान्ययुगं च]

ग्रहाणां प्राङ्मुखी भुक्तिः स्वव्यापारकृतोदिता ।
दृक्संवादविशुद्धासौ गृह्यते गोलवित्तमैः ॥ ८० ॥

यत्कृतो निखिलः कालो वर्षमासदिनादिकः ।
ग्रहभुक्ति विना यस्मान्न कालो जातु जायते ॥ ८१ ॥

तथा[2] कृत्स्नस्य कालस्य व्याप्तिस्तदवगम्यते ।
ग्रहाणां यत्र सर्वेषां भुक्तिर्भगणरूपिणी ॥८२ ॥

सावनै[3]र्द्युगणैर्व्याप्ता[4] निरंशत्वेन तद्युगम् ।
तादृशानि युगानि स्युरन्तरा सुबहूनि चेत् ॥ ८३ ॥

पूर्वाचार्यानुरोधेन तादृशं कथितं युगम् ।
अत्रान्तरा बहूनि स्युः कुजादीनां युगानि हि ॥ ८४ ॥

रसाद्रिबाणा भगणा नियता रविसावनैः ।
नवाष्टज्वलनाकाशमूर्च्छनाप्रमितै रवेः ॥ ८५ ॥

चन्द्रस्यापि षडङ्कर्तुशैलाष्टद्विरदाश्विभिः ।
नियताः स्युः शराद्रिषष्टबाणाङ्काष्टाहिभूधराः[5] ॥ ८६ ॥

नियता भगणाः कौजा भूपाश्व्यब्ध्यद्रिसायकाः ।
बाणाद्रिपुष्कराङ्काद्रिवेदाब्ध्यङ्कहुताशनैः ॥ ८७ ॥

बुधस्य वेदबाणाद्रिवेदाङ्कार्णव[6]भूमिभिः ।
बाणार्कहुतभुङ्नन्दशक्वरीविश्वसम्मिताः ॥ ८८ ॥

व्याख्या—1. D. विश्लेष　　2. C. तया for तथा
3. D. सागर्णै　　4. A. B. न्यासा
5. A. भूरयः
6. A. C. वेदाङ्काणयः (C. °य); B. वेदाङ्का-gap-य

गुरोरङ्काभ्रनेत्राहिभूमिभिर्नियता गणैः ।
शर्विवसुबाणाङ्कनागस्तम्बेरमाग्नयः ॥ ८९ ॥

भगणैर्नन्दवस्वेकशरवस्विषुभिर्भृगोः ।
बाणार्कपुष्कराङ्काब्धिरूपवह्निनिशाकराः ॥ ९० ॥

नियता भगणैर्मन्दिर्गुणेष्वङ्करसाग्निभिः[1] ।
बाणाद्रिपुष्कराङ्काद्रिवेदाब्ध्यङ्कहुताशनाः ॥ ९१ ॥

रूपाभ्रखाब्धयस् तोङ्गा भगणा नियता दिनैः[2] ।
खेष्वद्रिहुतभुग्वह्निनन्दाब्दैरर्कसावनैः[3] ॥ ९२ ॥

पातस्य हुतभुग्दन्त[4]यमला नियता दिनैः ।
शर्विभूमिनन्दाद्रिमहीधरशरेन्दुभिः ॥ ९३ ॥

शराद्रिसुरनन्दार्के रसाभ्राग्नीन्दवोऽधिकाः ।
तिथयो वस्त्रामग्निपुष्कराब्धिगुणेन्दवः ॥ ९४ ॥

तिथिक्षयाश्च सप्ताभ्ररसाग्निवसवो दिनैः ।
तत्त्वाश्वाङ्केषु[5]नेत्राक्षैर्नियता रविसावनैः ॥ ९५ ॥

सन्तीत्थं भगणाद्यैः स्वैर्नियता रविसावनाः ।
निरंशत्वं तु सर्वेषां युगपद् यत्र तद् युगम् ॥ ९६ ॥

इति चेत् तादृशान्यत्र सन्त्येव सुबहून्यपि ।
पूर्वाचार्यानुरोधेनैवोक्तमेतादृशं युगम् ॥ ९७ ॥

गतिभेदेऽभ्युपगते तस्मिन्नेव युगे ततः ।
भगणा एव केषांचित् ग्रहाणां परिवर्तिताः ॥ ९८ ॥

संस्कारच्छद्मनैवान्ये यथा मध्ये न्यधुर्भिदाम्[6] ।
सावनो द्युगणो भास्करोक्त एव प्रदर्शितः ॥९९॥

[अधिकावमयुक्तिः]

अधिकावमयोरुक्तिर्यदेषा युगनिष्ठयोः ।
न परं द्युगणार्थं सा[7] किन्त्वर्केन्द्वोः स्वमध्यमे ॥ १००॥

व्याख्या—1. D. रसादिभिः 2. B. गणैः
3. B. नन्दार्कैरकं सावनैः
4. A. पातभूस्यनभूर्दन्तः; B. पातस्य हूतभूर्दन्त
5. A.B. तत्त्वाश्चाङ्केषु
6. A. न्युदुर्भिदाम् ; B. न्यपुर्भिदाम् ; C. व्यपुर्भिदाम् ; D. यधुर्भिदाम्
7. A. या

आचार्यसम्मतान् मार्गभेदान् दर्शयितुं स्फुटम् ।
ग्रहाः सर्वे यथासिद्धयविवादं ग्रहान्तरात् ॥ १०१ ॥

अधिकावमयोः शेषात् तद्वत् सावयवावपि ।
यद्वा चान्द्रमसा मासाः सूर्येन्द्वोर्भगणान्तरम् ॥ १०२ ॥

सूर्यातिरिक्तेन्दुगतिश्चान्द्रः कालो भवेद् यतः ।
तथाहि वृत्तमार्गेण भ्राम्यतोर्ग्रहयोर्द्वयोः ॥ १०३ ॥

भगणान्तरतः स्वल्पा[1]नल्पभुक्त्योर्युतिर्भवेत् ।
स्वल्पभुक्त्यतिरिक्तान्यगत्या योगस्तयोस्ततः ॥ १०४ ॥

चान्द्रा मासाश्च[2] सूर्येन्द्वोर्योगा एव युगोद्भवाः ।
पर्ययान्तरतोर्केन्द्वोश्चान्द्रमासा भवन्त्यतः ॥ १०५ ॥

अधिकाः सौरमासेभ्यश्चान्द्राः स्युरधिमासकाः ।
सौरमासाश्च[3] ते द्वादशाभ्यस्ताः सूर्यवत्सराः ॥ १०६ ॥

सूर्यपर्ययतुल्यास्ते तदूनाच्चन्द्रपर्ययात् ।
द्वादशघ्नार्कभगणे त्यक्ते स्यादधिमासकः ॥ १०७ ॥

अतोऽधिकसमानीतं मध्यमं ग्रहमध्यवत् ।
त्रयोदशघ्नेऽर्कमध्ये क्षिपेच्चन्द्रस्य सिद्धये ॥ १०८ ॥

त्यक्तेऽस्मिंश्चन्द्रमध्याद् वा त्रयोदशहृतो[4] रविः ।
अधिवत्सरशश्यब्दनीतयोर्वाथ मध्ययोः[5] ॥ १०९ ॥

विश्लेषो वार्कमध्यस्य द्वयोर्भेदोऽर्कपर्ययः ।
यथा भेदोऽधिमासः स्यान्मासयोः सौरचान्द्रयोः ॥ ११० ॥

सौरचान्द्राब्दयोस्तद्वद् विशेषोऽ[6]प्यधिवत्सरः ।
त्रयोदशहृतेऽर्कस्य पर्यये चन्द्रपर्ययात् ॥ १११ ॥

त्यक्ते सत्यधिमासानामुत्पत्तिः प्राक् प्रदर्शिता ।
शश्यब्दस्तत्र रव्यब्दादधिकाब्दाधिको भवेत् ॥ ११२ ॥

चान्द्रमासाः सौरमासावधिमासाधिका यतः ।
त्रयोदशघ्ने शश्यब्दे रव्यब्दाः स्युस्त्रयोदश ॥ ११३ ॥

अधिकाब्दाश्च तावन्तश्चान्द्राब्दास्तद्युतिर्यतः ।
त्रयोदशघ्नोऽधिकाब्दोऽधिकः स्वेनाधिमासकः[7] ॥ ११४ ॥

व्याख्या—1. D. भगणान्तरस्स्वल्पा　　2. D. चान्द्रमासाश्च
3. A. वारमासाश्च; B. D. सौरमास्याश्च　　4. A. B. हृतो
5. C. Hapl. om. after मध्ययोः to चान्द्रयोः of verse 110.
6. B. विश्लेषो　　7. B. D. मासतः

द्वादशघ्नोऽधिकाब्दो[1] येनाधिमास इति स्मृतः ।
त्रयोदशघ्नाः सूर्यस्य पर्ययाः साधिमासकाः ॥ ११५ ॥

चान्द्राः स्युर्भगणास्तत्र यदि चान्द्रोऽपि वत्सरः ।
त्रयोदशघ्नः क्रियते सोऽधिकाब्दाधिकस्ततः ॥ ११६ ॥

अतो विश्वघ्नशश्यब्दादधिकाब्दे विशोधिते ।
शिष्यते चन्द्रभगण इत्येतदुपपद्यते ॥ ११७ ॥

ततो युगाधिकहतात् क्ष्माहैरवमशेषतः ।
लब्धेन युक्तादधिकशेषाच्चान्द्रमसैर्दिनैः ॥ ११८ ॥

लब्धं दिनादिकं त्याज्यं चंद्रादितिथिसञ्चयात्[2] ।
केवलाद् विश्वनिहताच्चार्कचन्द्रौ लवादिकौ ॥ ११९ ॥

स्यादेतद्यदि विज्ञातास्तिथयोऽवयवान्विताः ।
तदभावे[3] कथं याततिथीनां सूक्ष्मता भवेत् ॥ १२० ॥

तदर्थं सावनदिनैर्व्यष्टिघ्नादवमशेषतः ।
लब्धं[4] कलादि चंद्रादेर्यातासु तिथिषु क्षिपेत् ॥ १२१ ॥

ततः प्राग्वत्समानीतमधिशेषफलं त्यजेत् ।
अर्केन्द्वोर्मध्यमविधावुपायान्तरमीदृशम् ।
दर्शयन् भगणान् कृत्स्नान् युगसम्बन्धिनो व्यधात् ॥ १२२ ॥

[ग्रहयोगेन भगणपरीक्षणम्]

युगादौ भगणादीनां किंकृतेयं व्यवस्थितिः ।
अतीन्द्रियत्वात् प्रत्यक्षं यत्र नैव प्रवर्तते ॥ १२३ ॥

तन्मूलादनुमानाच्च दुष्करस्तद्विनिश्चयः ।
न ग्रहग्रहयोगादेः प्रत्यक्षविषयत्वतः ॥ १२४ ॥

ज्ञातभुक्तेर्द्वयोर्योगात् सिद्ध्येत् तदितरो ग्रहः ।
अतुल्यभुक्त्योरुभयोर्भुक्त्या स्वल्पातिरिक्तया ॥ १२५ ॥

वृत्ताकारेण मार्गेण भ्रमतोर्योगसम्भवः ।
स्वल्पगत्यन्विताद्योगात् स्यादनल्पगतिस्ततः ॥ १२६ ॥

योगोनितानल्पगतेः स्वल्पभुक्तिर्भवेदपि ।
योगः स्वल्पानल्पभुक्त्योर्भुक्त्यन्तरकृतो यतः ॥ १२७ ॥

व्याख्या—1. B. धिमासो for धिकाब्दो   2. A. सम्भवात्
3. A. C. तदाभावे   4. A. प्रलब्धं

ततः क्षित्यर्कयोगोनावर्कभुक्तिः क्षितेः भ्रमात् ।
अर्केन्द्वोर्योगसंयुक्तावर्काच्चन्द्रो भवेत् तथा ॥ १२८ ॥

चन्द्रभौमादियोगोनाच्चन्द्रात् भौमादयस्तथा ।
ग्रहणग्रहयोगादेस्ततः प्रत्यक्षसिद्धतः ॥ १२९ ॥

उक्तरूपेण मार्गेण तद्व्यवस्था न दुष्करा ।
ननु नीचोच्चवृत्ते स्वे भ्राम्यति प्रतिमण्डलम् ॥ १३० ॥

ग्रहस्तत्परिधौ नित्यं स्वगत्या प्राङ्मुखं व्रजेत् ।
अतो निरर्गलत्वं तु ग्रहभुक्तेः प्रसज्यते ॥ १३१ ॥

सत्यं भूयःपरीक्षातः सा बुधैस्त्वनुमीयते ।
नीचोच्चवृत्ते स्वोच्चस्थकेन्द्रं तत्प्रतिमण्डलम् ॥ १३२ ॥

यात्युच्चभुक्त्या तन्नेम्यां प्राङ्मुखं गच्छति ग्रहः ।
विप्रकर्षः परो यत्र तत्र नीचोच्चकेन्द्रतः ॥ १३३ ॥

तत्रोच्चं[1] कल्प्यते नीचं चक्रार्धान्तरितं ततः ।
सन्निकर्षः परस्तत्र ग्रहनीचोच्चकेन्द्रयोः ॥ १३४ ॥

तुल्यकालान्तरितयोः पार्श्वयोरुभयोर्यतः ।
विप्रकर्षो भवेत् तुल्यो नीचोच्चजनितो हि सः ॥ १३५ ॥

तन्मध्यगतमुच्चं च नीचं च प्रतिमण्डले ।
अन्तरं पार्श्वयोस्तुल्यकालयोर्भिन्नमन्यतः[2] ॥ १३६ ॥

अत्यल्पो विप्रकर्षः स्याद्यतस्तत्पार्श्वयोर्द्वयोः ।
तन्मध्यगतमुच्चं तत्रानल्पे नीचसंस्थितिः ॥ १३७ ॥

[3][स्वदोःफलचापाद्वा प्रसाध्या] [4]तन्महदल्पता ।
नीचोच्चवृत्तव्यासार्धं दोःफलं परमं भवेत् ॥ १३८ ॥

तत्कोटिफलयुग्व्यासदलेनोर्ध्वंस्थितो[5] ग्रहः ।
उच्चासन्नस्तदूनेन नीचासन्नस्त्वधोगतः ॥ १३९ ॥

तस्य तद्दोःफलस्यापि कर्णौ वर्गयुतेः पदम् ।
नीचोच्चवृत्तग्रहयोः कर्णः स्याद् विवरं सदा ॥ १४० ॥

कर्णे महति बिम्बोऽल्पो ग्रहाणां स्वल्पके महान् ।
बिम्बानां महदल्पत्वं स्पष्टं स्याद् ग्रहणादिषु ॥ १४१ ॥

व्याख्या—1. A. B. D. ततोच्चं 2. A. मन्यदा

3. Mss. read स्वदोःफलावापोद्वापसाध्या (A. om. दोः)

4. For त following, A has क, B. क with त written above and D. त, correctly. 5. B. स्थितौ

व्यक्तं परीक्षणीयेत्थं[1] स्थितिरत्नोच्चनीचयोः ।
नीचोच्चवृत्तव्यासार्धं तत्रान्त्य[2]फलसंज्ञितम् ॥ १४२ ॥

एतदर्थं हि तत्कक्ष्याप्रतिमण्डलयोर्द्वयम् ।
कक्ष्यामण्डलकेन्द्रस्थं नीचोच्चं च प्रकल्प्यते ॥ १४३ ॥

भगोलमध्यकेन्द्रं च भवेन्नीचोच्चमण्डलम् ।
प्रतिमण्डलकेन्द्रं च स्वोच्चे नीचोच्चमण्डले ॥ १४४ ॥

प्रतिमण्डलतो गच्छन् स्वया गत्यान्वहं ग्रहः ।
कक्ष्यावृत्ते स्वनीचोच्चवृत्तमध्यस्थकेन्द्रके ॥ १४५ ॥

प्रतिमण्डलतुल्येऽथ भगोले वा विधीयते ।
स्फुटीकरणतो येन गतिः सैवाव्यवस्थिता ॥ १४६ ॥

व्यवस्थितैव लक्ष्येत ग्रहाणां प्रतिमण्डले ।
स्पष्टीकरिष्यते चैतदुपरि स्फुटकर्मणि ॥ १४७ ॥

प्रत्यक्षसिद्धात् सम्बन्धात् कालभुक्त्योरितीदृशात् ।
इयत्ता भगणादीनां युगादिष्वनुमीयते ॥ १४८ ॥

आचार्यैस्तदिदं[3] ज्योतिर्मीमांसायां च दर्शितम्[4] ॥ १४९ ॥

[अनुमानादिना भगणपरीक्षणम्]

अर्थापत्त्यनुमानाभ्यां भगणादिर्नियम्यते ।
युगादिषु यतस्तत्र न स्यादन्धपरम्परा ॥ १५० ॥

भगोलमध्यकेन्द्रं यत् कक्ष्यावृत्तं द्युचारिणाम् ।
[ये][5] तु तत्परिधौ यान्ति[6] ग्रहास्ते तुल्यभुक्तयः ॥ १५१ ॥

भगोलविषया भुक्तिस्तुल्यरूपा यतो भवेत् ।
वृत्तयोः केन्द्रभेदेन गत्योरत्र विभिन्नता ॥ १५२ ॥

अतस्तत्केन्द्रतः स्वान्त्यफलान्तरितकेन्द्रके ।
निजोच्चदिशि तत्तुल्ये[7] यान्त्यमी प्रतिमण्डले ॥ १५३ ॥

व्याख्या—1. A. D. णीयेर्थं   2. A. तत्राम्य
3. A. सुराचार्यैरिदं; B. आचार्यैरिदं
4. A. प्रदर्शितम् for च दर्शितम्   5. Mss. न for ये
6. D. यन्ति
7. A. निजोच्चदर्शितं तुल्ये ; B. निजोच्चा दिशि तत्तुल्ये ; D. निजोच्च-दिशतत्तुल्ये

भगोलापावनाद् भुक्तेस्तस्याः स्याद् भिन्नरूपता ।
प्रत्यहं भिन्नरूपत्वं भुक्तीनां चानुभूयते ॥ १५४ ॥

भुक्तयोरनयोरन्त्यफलतो विप्रकृष्टता ।
प्रत्यक्षेणावगम्येत मध्ये नीचोच्चयोर्द्वयोः ॥ १५५ ॥

कालेन यावता स्वोच्चाद् ग्रहो नीचाश्रितो भवेत् ।
नीचतोऽपि व्रजेदुच्चं द्वयोरपि तदर्धयोः ॥ १५६ ॥

नीचोच्चवृत्तव्यासार्धेनाग्रतः पृष्ठतोऽपि च ।
कक्ष्यामण्डलनीचोच्चस्थितो मध्यान्न भिद्यते ॥ १५७ ॥

किन्तु स्वान्त्यफलेनास्मादधऊर्ध्वस्थितो भवेत् ।
तद्बिम्बमहदल्पत्ववशादेतत्तु गम्यते ॥ १५८ ॥

ग्रहणग्रहयोगादौ तत्तु स्पष्टीकरिष्यते ।
स्वोच्चतो नीचतो वापि विप्रकर्षो ग्रहस्य यः ॥ १५९ ॥

ततः स्वान्त्यफलव्यासार्धाभ्यां त्रैराशिकागतम् ।
मध्यस्फुटान्तरालं स्यात् सर्वत्रापीष्टकालजम् ॥ १६० ॥

ततः स्वान्त्यफलव्यासवलं नीचोच्चमण्डलम् ।
कक्ष्यावृत्तस्य परिधौ याति नीचोच्चमण्डलम् ॥ १६१ ॥

मध्यभुक्त्याथवा तस्य परिधौ प्रतिमण्डलम् ।
कक्ष्यामण्डलकेन्द्रस्थ[1]स्वकेन्द्रस्योच्चभुक्तितः[2] ॥ १६२ ॥

अनिवृत्त्या ग्रहादीनां पर्ययावृत्तिसम्भवात् ।
वृत्तमार्गेण सर्वेषां भ्रमणं[3] तूपपद्यते ॥ १६३ ॥

गोलस्वरूपे शास्त्रोक्तगणितावगते ततः ।
उच्चनीचपरिध्यादिरर्थापत्त्या नियम्यते ॥ १६४ ॥

अतीन्द्रियाश्च भगणा नियम्यन्तेऽनुमानतः ।
तेषां शास्त्रेषु नानात्वं परीक्षातारतम्यतः ॥ १६५ ॥

व्याख्या—1. B. D. केन्द्रस्य ; C. स for स्व following.

2. A. भुक्तिता　　3. D. भ्रामणं

सुग्रहत्वाय तत्सिद्धं सर्वं यत्रोपदिश्यते ।
अतः सर्वेषु शास्त्रेषु न्यायमार्गप्रदर्शिषु ।
संख्याभागं[1] पृथक्कृत्य बभणुर्गोलचिन्तकाः ॥ १६६ ॥

इति ॥

[वृत्तेषु ग्रहभ्रमः]

नानाविधानां वृत्तानां स्वनेमिस्थग्रहचारिणाम् ।
प्रवहस्कन्धगामित्वात् तुल्यकालो भ्रमो भवेत् ॥ १६७ ॥

यतस्तेषां विनानां च मिथः स्यात् तुल्यकालता ।
स्ववृत्ते प्राग्भ्रमेणैव केवलं भेदसम्भवात् ॥ १६८ ॥

तुल्यरूपा भवेद् भुक्तिः सर्वेषां योजनात्मिका ।
अतुल्यरूपता चास्याः स्ववृत्तप्रमितत्वतः ॥ १६९ ॥

महती स्यात् कलाभुक्तिः स्वल्पवृत्तकलामिता ।
वृत्तेन महता सैव प्रमिता स्वल्पिका[2] भवेत् ॥ १७० ॥

वृत्तावयववैचित्र्याद् भुक्तिरेकैव शाश्वती ।
[तत्तत्कलामिता][3] तस्मात् भजते भिन्नरूपताम् ॥ १७१ ॥

स्ववृत्ते पर्ययास्तेषां भिन्नकाला भवन्त्यतः ।
युगे पर्ययनानात्वं ग्रहाणां येन दृश्यते ॥ १७२ ॥

अमल्पभुक्तेः स्वल्पं स्यात् वृत्तमल्पगतेर्महत् ।
भगोलमध्यतस्तेषां स्ववृत्ताल्पमहत्त्वतः ॥ १७३ ॥

अधऊर्ध्वं च[4] सञ्चारो वेद्यः स्वान्त्यफलाद्विव ।
योजनात्मिकया गत्या प्रत्यहं तुल्यरूपता ॥ १७४ ॥

युगेनाकाशकक्ष्याया योजनानि व्रजन्त्यमी ।
खकक्ष्यातः[5] स्वकक्ष्या स्याद् विभक्ता युगपर्ययैः ॥ १७५ ॥

स्वकक्ष्यया खकक्ष्यातो हृता वा युगपर्ययाः ।
घातो यतः स्वकक्ष्या [स्या]द् युगपर्ययकक्ष्ययोः ॥ १७६ ॥

व्याख्या—1. B. भावं 2. C. स्वल्पका ; D. स्वल्पता
3. A. C. तत्तत्कालामिता; B. D. तत्तत्कालामिता
4. B. ऊर्ध्वंश्च 5. A. B. स्वकक्ष्यातः

[कलिदिनानयनम्]

द्वादशघ्नान् कलेरब्दान् मासैश्चैत्रादिभिर्गतैः ।
संयुक्तान् पृथगाहत्याप्यधिमासैस्ततो हृतैः ॥ २३ ॥
सौरमासैर्युगोक्तैस्तैरधिमासैर्युतान् गतैः ।
मासांश्च त्रिंशता हत्वा तिथीर्युक्त्वा गतः पृथक् ॥ २४ ॥
तिथिक्षयैर्निहत्यातो युगोक्ततिथिभिर्हृतान् ।
अवमाञ्छोधयेच्छेषः सावनो द्युगणः कलेः ॥ २५ ॥
सप्तभिः क्षपिते शेषाच्छुक्रादिः स्याद् दिनाधिपः ।

दिनयोजनभुक्तिश्च विभक्ता युगभूदिनैः ।
भवेदम्बरकक्ष्यायाः सा तद्घातो भवेद्यतः ॥ १७७ ॥

दिनयोजनभुक्तिघ्ना दिष्टाहर्गणतस्ततः ।
स्वकक्ष्यया विभज्याप्तो[1] मध्यमो भगणादिकः ॥ १७८ ॥

भवेदवयवच्छेदाभ्यस्तशेषात् समुद्धृतैः[2] ।
मुहुः स्वावयवैर्युक्त इत्येतद् युज्यते ततः ॥ १७९ ॥

इति ॥

[कलिदिनानयनम्]

द्वादशघ्नान् कलेरब्दान् (I. 23-26a) इति—

रविपर्ययकालोऽत्र रव्यब्दः परिकीर्तितः ।
भगोलद्वादशांशेषु सौरमासो रवेर्भ्रमः ॥ १८० ॥

चान्द्रमासाश्च चान्द्रार्कयोगतुल्याः प्रकीर्तिताः ।
भ्रमणं प्रवहायत्तं सावनं च दिनं रवेः ॥ १८१ ॥

त्रिंशांशश्चान्द्रमासस्य तिथिश्चान्द्रदिनात्मिका ।
वत्सराः सौरतः सिद्धास्तत्र मासाश्च चान्द्रतः ॥ १८२ ॥

दिनानि सावनानीति सर्वेषामपि सम्मतम् ।
मासाः सावयवाः सन्ति प्रत्यब्दं द्वादशैव ते ॥ १८३ ॥

व्याख्या—1. B. विभज्यातो   2. C. तदुद्धृतैः

सौरमासो परो राशिभोगकालो रवेरपि ।
द्वादशघ्ना भवन्त्यब्दाः सौरमासाः कलेर्गताः ॥ १८४ ॥

प्रक्षिपेद् वर्तमानाब्दे तत्र मासान् गतानपि ।
स्यादेतद् वर्तमानाब्दे सौरास्ते विदिता इति ॥ १८५ ॥

न त्वेवं चान्द्रमासानां चैत्रादीनां प्रतीतितः ।
सत्यं किन्त्विह चैत्राद्या यातसौरसमा यदा ॥ १८६ ॥

तदा चैत्रादियोगाच्च सौराः स्युः सुकरा गताः ।
तदाधिकविनैरेव भेदो यत्सौरचान्द्रयोः ॥ १८७ ॥

यदा तु वर्तमानेऽब्दे सम्पतेदधिमासकः ।
तत्राधिकेन तेनैव चान्द्राः स्युः सौरतोऽधिकाः ॥ १८८ ॥

चान्द्रमासास्तदाप्येका ग्राह्याश्चैत्रादयस्ततः ।
अधिमासतया तस्य पुनःप्रक्षेपसम्भवात् ॥ १८९ ॥

सौरेष्वेवास्य यातेषु प्रक्षेपोऽप्युपपद्यते ।
अधिकोनास्तु ये चान्द्रा सौरमासा भवन्ति ते ॥ १९० ॥

अधिकः सौरतश्चान्द्रः तेनैवाभिनवेऽधिके ।
चैत्रादय[1]स्ततोऽप्येताः कल्प्यन्ते सौरसिद्धये ॥ १९१ ॥

यातत्वेनाधिकत्वेनाप्येको द्विर्न तु युज्यताम् ।
यद्येवं यातचैत्रादिविनियोगेऽधिकोऽन्तिमः ॥१९२ ॥

चान्द्रच्छेदो[2] भवेद्यस्य[3] सम्भवोऽतीतचान्द्रकः[4] ।
इच्छाप्रमाणयोरेकजातीयत्वोपपत्तितः ॥ १९३ ॥

अतो युगाधिमासोऽत्र त्यज्यतेऽधिकशेषतः ।
वर्तमानाधिकावाप्तावन्यथासौ न वास्तवः ॥ १९४ ॥

चैत्रादिभ्यः पृथग्भूतो यतोऽसावधिकः पतेत् ।
द्वादशघ्नेषु वर्षेषु वर्तमानाब्दसम्भवैः ॥ १९५ ॥

चैत्रादिमासैर्युक्तेषु युगाधिकहृतात् स्वतः ।
युगसौरोद्धृतातीताधिमाससहितेष्वतः ॥ १९६ ॥

व्याख्या—1. D. चैत्रादिक　　2. C. चन्द्रच्छेदो
3. D. भवेन्त्यस्य　　4. C. D. चान्द्रतः

युगाधिकस्य शोध्यत्वे तत्रैवाधिकशेषतः ।
याताधिमासाः पूर्णाः स्युरन्यथान्त्यो न पूर्यते ।। १९७ ।।

दिनीकृता वर्तमानचान्द्रातीतदिनान्विताः ।
पृथग् युगावमाभ्यस्ता युगचान्द्रदिनोद्धृताः ।। १९८ ।।

त्यक्त्वा यातावमैर्लब्धैः सावनाहर्गणो गतः ।
तिथ्यन्तावधिकः सः स्यान्न तु रव्युदयावधिः ।। १९९ ।।

अतीततिथिसंयोगे प्रक्षिप्यन्ते दिनानि यत् ।
तिथयः सावनाहेभ्यः पूर्वमेव समाप्नुयुः ।। २०० ।।

स्वल्पत्वात् स्वैरवयवैरुदयावधयश्च ताः ।
युगभूदिनभक्ताः स्युस्ते चान्त्यावमशेषतः ।। २०१ ।।

वर्तमानोऽवमः सावनाहेभ्यो गृह्यते यतः ।
उदयावधिकान्यर्कसावनानि दिनानि हि ।। २०२ ।।

न पुनस्तिथयो यासां समाप्तिः सावनात् पुन।[1] ।
उदयावधयो नित्यं तिथयोऽवयवान्विताः ।। २०३ ।।

नन्वत्रावमशेषोत्थचान्द्रावयवसंयुतैः ।
यातचान्द्रदिनैर्नीतो वर्तमानोऽधिकः स्फुटः ।। २०४ ।।

अतो युगाधिकाभ्यस्तात् क्ष्माहैरवमशेषतः ।
लब्धयुक्तोऽधिमासस्य शेषः पूर्वोदितः स्फुटः ।। २०५ ।।

युगचान्द्रदिनैर्भक्तास्ततो[2] मासादयोऽधिकाः ।
त्याज्यास्तैर्भूदिनैर्भक्तात् पूर्वोक्तावमशेषतः ।। २०६ ।।

दिनानि रूपाद्यैर्वाधिमासतिथ्यन्वितात् ततः ।
चन्द्रस्त्रयोदशाभ्यस्ताच्छिष्टोऽर्कः केवलादपि ।। २०७ ।।

इत्थं चन्द्रार्कयोरेव मध्यमानयनं प्रति ।
विशेषो दर्शितोऽनेन [3]ब्रुवतेत्थमहर्गणम् ।। २०८ ।।

व्याख्या—1. D. पुरः 2. B. स्त्वतो
3. A. ब्रुवतेय ; C. ब्रुवतेर्थमहर्गणम् ।। इति ।

[परिकर्माणि]

अथ त्रैराशिकं वक्तुं परिकर्माऽवितो ब्रुवे ।
तत्तु सङ्कलिताद्युक्तं यत् सिद्धान्तशिरोमणौ ॥ २०९ ॥

[सङ्कलनव्यवकलिते]

कार्यः क्रमादुत्क्रमतोऽथवाङ्कयोगो यथास्थानकमन्तरं वा ॥ २१० ॥

(लीलावती, १२)

[गुणनम्]

गुण्यान्त्यमङ्कं गुणकेन हन्यादुत्सारितेनैवमुपान्तिमादीन् ।
गुण्यस्त्वधोऽधो गुणखण्डतुल्यस्तैः खण्डकैः संगुणितो युतो वा ॥ २११ ॥
भक्तो गुणः शुध्यति येन तेन लब्ध्या च[1] गुण्यो गुणितः फलं वा ॥
द्विधा भवेद् रूपविभाग एवं स्थानैः पृथग्वा गुणितः समेतः ॥ २१२ ॥
इष्टोनयुक्तेन गुणेन निघ्नोऽभीष्टघ्नगुण्यान्वितवर्जितो वा ॥ २१३ ॥

(लीलावती, १४-१६)

[भागहरणम्]

भाज्याद् हरः शुध्यति यद्गुणः स्यादन्त्यात् फलं तत् खलु भागहारे ।
समेन केनाप्यपवर्त्य हारभाज्यौ भवेद् वा सति सम्भवे तु ॥ २१४ ॥

(लीलावती, १८)

[वर्गपरिकर्म]

समद्विघातः कृतिरुच्यतेह स्थाप्योऽन्त्यवर्गो द्विगुणान्त्यनिघ्नाः ।
स्वस्वोपरिष्टाच्च तथा परेङ्कास्त्यक्त्वान्त्यमुत्सार्य पुनश्च राशिम् ॥ २१५ ॥
खण्डद्वयस्याभिहतिर्द्विनिघ्नी तत्खण्डवर्गैक्ययुता कृतिर्वा ।
इष्टोनयुग्राशिवधः कृतिः स्यादिष्टस्य वर्गेण समन्वितो वा ॥ २१६ ॥

(लीलावती, १९-२०)

[वर्गमूलम्]

त्यक्त्वान्त्याद् विषमात् कृतिं द्विगुणयेन्मूलं समे तद्धृते
त्यक्त्वा लब्धकृतिं तदाद्विविषमाल्लब्धं द्विनिघ्नं न्यसेत् ।

व्याख्या—1. A, लब्ध्याथ

पङ्क्त्यां पङ्क्तिहृते समेऽन्त्यविषमात् त्यक्त्वाप्तवर्गं फलं
पङ्क्त्यां तद् द्विगुणं न्यसेदिति मुहुः पङ्क्तेर्दलं स्यात् पदम्[1] ॥ २१७ ॥
(लीलावती, २२)

[भागजातिः]

अन्योन्यहाराभिहतौ हरांशौ राश्योः समच्छेदविधानमेवम् ।
मिथो हराभ्यामपवर्तिताभ्यां यद्वा हरांशौ सुधियात्र गुण्यौ ॥ २१८ ॥
(लीलावती, ३०)

[प्रभागजातिः]

लवा लवघ्नाश्च हरा हरघ्ना भागप्रभागेषु सवर्णनं[2] स्यात् ॥ २१९ ॥
(लीलावती, ३२)

[भागानुबन्धभागापवाहौ]

छेदघ्नरूपेषु लवा धनर्णमेकस्य भागा अधिकोनकाश्चेत् ।
स्वांशाधिकोनः खलु यत्र तत्र भागानुबन्धे च लवापवाहे ।
तलस्थहारेण हरं निहन्यात् स्वांशाधिकोनेन च तेन भागान्[3] ॥ २२० ॥
(लीलावती, ३८)

[भिन्नसङ्कलित-व्यवकलितम्]

योगोऽन्तरं तुल्यहरांशकानां कल्प्यो हरो रूपमहारराशेः ॥ २२१ ॥
(लीलावती, ३७)

[भिन्नगुणनम्]

अंशाहतिश्छेदवधेन भक्ता लब्धं विभिन्ने गुणने फलं स्यात् ॥ २२२ ॥
(लीलावती, ३९)

[भिन्नभागहारः]

छेदं लवं च परिवर्त्य हरस्य शेषः ।
कार्योऽथ भागहरणे गुणनाविधिश्च ॥ २२३ ॥
(लीलावती, ४१)

व्याख्या—1. B. फलम् 2. A. सवर्णने
3. C. ते स्वभागात्

[भिन्नवर्गादि]

वर्गे कृतिर्घनविधौ च घनौ विधेयौ ।
हारांशयोरथ पदे च पदं विधेयम् ॥ २२४ ॥

(लीलावती, ४३)

[शून्यपरिकर्म]

योगे खं क्षेपसमं, वर्गादौ खं, खभाजितो राशिः ।
खहरः स्यात्, खगुणः खं, खगुणश्चिन्त्यश्च शेषविधौ ॥ २२५ ॥

शून्ये गुणके जाते खं, हारश्चेत्पुनस्तथा राशिः ।
अविकृत एव ज्ञेय,स्तथैव खेनोनितश्च युतः ॥ २२६ ॥

(लीलावती, ४५-४६)

[संख्यासिद्धान्तः]

पदार्थानां समस्तानां संख्या संख्यानसाधनम् ।
द्रव्यादिवद् यथा[1] संख्या सापि संख्यायते क्वचित् ॥ २२७ ॥

अभिन्नमथ भिन्नं च संख्येयं द्विविधं मतम्[2] ।
तत्राभिन्नस्य[3]मेकत्वं द्वित्वाद्यं भिन्नसाधनम्[4] ॥ २२८ ॥

अभिन्ने पूर्णरूपोंऽशिन्येकत्वमवतिष्ठते ।
द्वित्वादिकं पृथग्भूतेष्वस्यैवावयवेष्वपि ॥ २२९ ॥

यदि सङ्कलनाबुद्धिरनुगृह्णाति तान् मिथः ।
तदभावे पृथग्भूतेष्वप्येकत्वमवस्थितम् ॥ २३० ॥

[5]तथाहि ते पृथग्भूता गच्छन्त्येकैकमेकताम् ।
अभिन्ने स्फुटमेकत्वं भिन्नेषु पृथगेकता ॥ २३१ ॥

भेदाभेदकृतस्तस्माद् द्वित्वादिस्तद्विदां मतः ।
पूर्णरूपा अवयवा[6] यतस्तुल्याः[7] पृथक्कृताः ॥ २३२ ॥

व्याख्या—1. C. यया
2. A. C. Alternate reading भवेत् also given for मतम् ।
3. B. भिन्नत्व
4. A.B. D. साधनगोचरम्; C. साधनम् and गोचरम् as alt. readings.
5. C. यथा हि
6. D. पूर्वरूपादवयवात्
7. C, D. मिथस्तुल्याः

भिन्नरूपा भिदस्तस्माद् विभज्यन्ते न संख्यया ।
कुतश्चिद्यत्र सामान्यादभेदो भिन्नतापि[1] च ॥ २३३ ॥

भिन्नजातिष्वपि मिथस्तत्र द्वित्वादिकं भवेत् ।
एकत्वादिपरार्धान्ता संख्या संख्येयसंश्रिता ॥ २३४ ॥

अंशांशिनिष्ठितत्वेन द्विधैवाभ्युपगम्यते ।
अंशांशिकल्पना चेयं सापेक्षैव मिथोऽन्वयात् ॥ २३५ ॥

[2]तथा ह्यनुपलब्धेंऽशिन्यंशित्वं[3] वस्तुनः कथम् ।
नैवांशित्वं भवेदंशानुपलब्धौ च कस्यचित् ॥ २३६ ॥

अंशित्वव्यवहारस्तु रूपे लाक्षणिको भवेत् ।
येनांशिनि तु [4]रूपत्वं रूपेंऽशित्वं च भण्यते ॥ २३७ ॥

रूपाणां पूर्णरूपाणां छेदाप्तानां तथांशिनाम् ।
छेदच्छिन्नतया[5] साम्यमुभयेषां च सम्मतम् ॥ २३८ ॥

संख्यायाः स्थानसंज्ञादिकरणं व्यावहारिकम् ।
अन्यथा गणनां कर्तुं[6] तदानन्त्यान्न शक्यते ॥ २३९ ॥

एकैकयोगात् द्वित्वादिसंख्यैकस्मिन्निरन्तरम् ।
उत्तरोत्तर[7]संख्याः स्युस्ततः सङ्कलनात्मिकाः ॥ २४० ॥

तद्वदेकैकविश्लेषात् संख्याश्चाधोगता अपि ।
संख्यास्वरूपकथनाद् योगभेदौ ततः स्फुटौ ॥ २४१ ॥

क्षिप्यन्ते व्यक्तयो यावत्कृत्वो यत्र तथोऽथ सा ।
संख्यास्वरूपकथनादेवार्थत्वं प्रसिद्ध्यति ॥ २४२ ॥

एवं सङ्कलितं संख्यास्वरूपकथनाद् भवेत् ।
यावत्यो व्यक्तयः शोध्याः तत्संख्यापि च तावती ॥ २४३ ॥

व्याख्या—1. A. B. भिन्नदापि 2. A. B. D. तथाद्यनुप

3. A. शिन्यपरत्वं ; C. Hapl. om. of वस्तुनः कथम्

4. C. om. रूपत्वं to साम्यं, two lines below.

5. C. छेदहीनतया 6. B. गणना कर्तुं

7. C. om. उत्तरोत्तर

अधोगतेष्टसंख्याया इति भेदोऽपि सिद्धयति ।
तत्रैव लाघवार्थं तु कथिते परिकर्मणि ॥ २४४ ॥

वृद्धिक्षयात्मकत्वेन विभक्तं गणितं द्विधा ।
तत्र वृद्धयाश्रया[1] योगगुणवर्गघना मताः ॥ २४५ ॥

क्षयाश्रयौ भेदहारौ द्वे वर्गघनयोः पदे ।
वृद्धेः क्षयस्य च स्थानं तत् प्रत्येकं चतुर्विधम् ॥ २४६ ॥

संयोगादिषु यत् पूर्वं तत् परत्रोपयुज्यते ।
योगो गुणे, गुणो वर्गे, स घने चोपयुज्यते ॥ २४७ ॥

भागहारे वर्गमूले घनमूले तथापरः ।
त्रयाणामेवमूर्ध्वोर्ध्वमुपयोगक्रमो मतः ॥ २४८ ॥

तथाहि[2] यस्यकस्यापि गुण्यत्वे येनकेनचित् ।
गुणव्यक्तिहता गुण्यव्यक्तिः संयुज्यते मिथः ॥ २४९ ॥

राश्योर्योगाश्रय[3]स्तस्मान्नियमः क्रियते गुणे ।
वर्गेऽप्येष विधिर्यत्र राशिः स्वेनैव हन्यते ॥ २५० ॥

स्वेनात्र गुणनाद् राशेर्गुण एव नियम्यते ।
घनकर्मणि योगादित्रय[4]मप्युपयुज्यते ॥ २५१ ॥

तथा ह्यत्र घने राशिर्द्विघ्नेनैव निहन्यते ।
गुण्यो वा गुणवर्गेण गुण्यवर्गो गुणेन वा ॥ २५२ ॥

एवं संयोगगुणनावर्गे सिद्धो भवेद् घनः ।
भागहारादिषु तथा वियोगा[5]द्युपयुज्यते ॥ २५३ ॥

हार्यराशेर्यथास्थानं हारावृत्तेर्विशोधनात् ।
हारेऽथ मूले सदृशद्विघातो वर्गराशितः ॥ २५४ ॥

खण्डमूलेऽन्त्यखण्डस्य वर्गो द्विघ्नं च तत्पदम् ।
उपान्त्यखण्डगुणितमवर्गाद् वर्गतः कृतिम्[6] ॥ २५५ ॥

व्याख्या—1. B. श्रयो 2. A. B. तथापि
3. C. योगार्हयोः 4. A. क्रम for त्रय
5. A. द्वियोगा for वियोगा 6. A. गुणिता वर्गाद्वर्गस्ततः कृतिः

स्थानापकर्षणावृत्त्या[1] शोध्यानीति हि तत्क्रमः ।
एवं तु भागहारादौ वियोगाद्युपयुज्यते ॥ २५६ ॥

एतदष्टविधं वृद्धिक्षयस्थं गणितं ततः ।
व्याप्तोष्टाभिश्च[2] तैरेव कृत्स्नो गणितसञ्चयः ॥ २५७ ॥

गणितं सकलं वृद्धिक्षयाधीनं हि सर्वदा ॥ २५८ ॥

[3]गुणेन केनाप्यावृत्तिर्गुण्यस्य[4] गुणनेष्यते ।
स्थाने [5]यावति येऽङ्काः स्युर्गुणे तत्र स्थितैस्तु तैः ॥ २५९ ॥

गुण्य आवर्तनीयोऽत्र गुणाख्यपरिकर्मणा ।
आदौ गुणेन गुण्यान्त्यस्थानाङ्कान् गुणयेदिह ॥ २६० ॥

गुणिताऽगुणिताङ्कानां गुण्ये येन न सङ्करः ।
तथाहि गुण्यान्त्यपदे गुणेन प्रथमं हते ॥ २६१ ॥

उपान्त्यादिपदं नानुप्रविशेद् गुणितं फलम् ।
यत्पूर्णं पूर्णरूपेण हतं तत्स्थानतो निजात् ॥ २६२ ॥

ऊर्ध्वस्थानं प्रयात्येव न कदाचिदधो व्रजेत् ।
ततः प्राग्गुणितेऽन्त्याङ्के न केनाप्यस्य सङ्करः ॥ २६३ ॥

गुण्यस्याद्यपदाङ्केषु प्रागेव गुणितेषु तु ।
द्वितीयादिपदाभ्यस्ता व्रजेयुस्तादृशं पदम् ॥ २६४ ॥

तत्रत्यैरहताङ्कैस्ते सङ्कीर्यन्ते ततो हताः ।
अतोऽत्र गुणने पूर्वं गुण्यान्त्याङ्को निहन्यते ॥ २६५ ॥

गुणेन यत्र गुण्यान्त्यपदादिः सोऽपि तिष्ठति ।
अतोऽत्र गुण्यगुणयोः स्थानानामिह संयुतिः ॥ २६६ ॥

एकोना गुणितस्थानसंख्या सैव युतिः क्वचित् ।
स्थानद्वयनिविष्टत्वाद् द्वयोरन्त्याङ्कयोर्हतेः ॥ २६७ ॥

व्याख्या—1. A. B. कर्षणे वृत्त्या   2. C. व्याप्तोऽष्टभिश्च

3. Verses 259-295, गुणने to को नु शक्नुयात्, are the same as the verses under गुणकर्मणि संग्रहश्लोकाः in *Kriyakramakarī*, Com. on verse 17 of the *Līlāvatī* of Bhāskara II, (V.V.R. Inst., Hoshiarpur, 1975) ,pp. 16-19.

4. A. C. गुणस्य   5. C. यावति एकोस्य गुणे

गुण्यान्त्याङ्कान् गुणेनादौ हत्वोपान्त्यादिकं पुनः ।
गुण्यमुत्सार्य वा हन्याद् गुणं तमपसार्य वा ।। २६८ ।।

गुण्यस्याद्यपदाक्रान्तं हन्यादेवं[1] मुहुर्मुहुः ।
पदानां नियमो न स्यात्[2] गुण्यन्तेऽमूनि चेत् पृथक् ।। २६९ ।।

आदावुपान्त्यमाद्यं वोपाद्यं वा हन्यते यतः ।
एवं कात्स्न्र्येन गुण्यस्य गुणेन गुणनोदिता ।। २७० ।।

खण्डा गुणस्य ये गुण्यं तावद्धा परिकल्पयन् ।
खण्डाङ्कनिहतास्ते तु संयुक्ता गुणितं फलम् ।। २७१ ।।

गुणव्यक्तिमिता गुण्या योज्या वा गुणितं फलम् ।
गुण्यव्यक्तिमितान्[3] कृत्वा गुणान् युञ्जीत वा गुणे ।। २७२ ।।

गुणस्थानैस्तदङ्कैश्च हत्वा गुण्यं तु योजयेत् ।
रूपस्थानविभागेन द्विधेत्थं गुणनोदिता ।। २७३ ।।

निश्शेषहरणार्थं यः कल्पितो हारको गुणे ।
तेन हारेण गुणितं गुण्यं हन्यात् फलेन च ।। २७४ ।।

एष प्रकारो गुण्ये वा कल्प्यते सति सम्भवे ।
यत्रेष्टोनगुणाभ्यस्तो गुण्यः स्वस्वगुणाहतात् ।। २७५ ।।

इष्टघ्नगुण्येनोनः स्यात् स पुनः क्षिप्यते ततः ।
इष्टयुक्तेन गुणिते गुण्ये सोऽभ्यधिकोऽन्यतः ।। २७६ ।।

तत इष्टगुणो गुण्यस्त्याज्यः संवर्गतस्तयोः ।
इष्टोनयुक्ते गुण्ये तु गुण इष्टाहतस्तथा[4] ।। २७७ ।।

न्यूनोऽधिकश्च गुणितात् क्षेप्यस्त्याज्योऽप्यतोऽत्र सः[5] ।
इष्टोनयोर्द्वयोरन्येष्टाहतौ तावुभौ क्षिपेत् ।। २७८ ।।

तत्रेष्टयोर्द्वयोर्घाते क्षिप्ते स्याद् गुणितं फलम् ।
घाते तथेष्टयुतयोः स्वान्येष्टघ्नावुभौ त्यजेत् ।। २७९ ।।

व्याख्या—1. B. हन्यादेव 2. C. नियमोऽन्य(:) स्यात्
3. A. B. गुणव्यक्तिमितान् 4. C. इष्टाहतं तथा
5. C. त्याज्यो हृतोऽत्र सः

क्षिपेदिष्टाहतिं प्राग्वद् गुणितं तु फलं स्फुटम् ।
द्वयोरिष्टोनयुतयोर्युगपद् गुणगुण्ययोः ॥ २८० ॥

स्वल्पेष्टनिहतोऽनल्पस्तदिष्टनिहतोऽपरः ।
क्षेप्यस्त्याज्यश्च संवर्गाद् द्वयोरिष्टाहतिं त्यजेत् ॥ २८१ ॥

गुणगुण्यद्वयाभ्यासादिष्टघातोऽधिको यतः ।
तद्युक्तिः छेद्यके[1] सम्यग् बोधनीया[2] विचक्षणैः ॥ २८२ ॥

गुण्यव्यस्तायतं[3] घातक्षेत्रं स्याद् गुणविस्तृतम् ।
समकर्णं च तद्वेद्यं तथायतचतुर्भुजम् ॥ २८३ ॥

पार्श्वद्वितयसंवर्गात् तत्र क्षेत्रफलं स्फुटम् ।
गुण्यपार्श्वे प्रतिव्यक्ति छिन्नाः खण्डाः गुणायताः ॥ २८४ ॥

गुणपार्श्वे च तत्तुल्यं छिन्नाः खण्डाः पृथक् ततः ।
कुतश्चित्कोणतो गुण्यखण्डान्ते खण्डयेत् ततः ॥ २८५ ॥

अन्यत्र गुणखण्डान्ते पार्श्वे प्रतिभुजावधि ।
खण्डघातात्मकाः खण्डास्ततो घाते भवन्ति हि ॥ २८६ ॥

यावदिच्छं च ते खण्डाः कल्प्यन्तां गुणगुण्ययोः ।
इष्टोनाल्पहतेऽनल्पेऽनल्पदीर्घेष्टविस्तृतम् ॥ २८७ ॥

क्षेत्रं त्वपरिपूर्णं स्यात् क्षिप्यते तेन तत्र तत् ।
इष्टान्वितात्पघ्नेऽनल्पे त्वाधिक्यात् तद्विशोध्यते ॥ २८८ ॥

इष्टोनयुतयोर्घाते युगपद् गुणगुण्ययोः ।
[4]इष्टोनस्त्वधिकेष्टघ्नो वास्तवादतिरिच्यते ॥ २८९ ॥

अत एवाधिकेष्टघ्न इष्टोनः शोध्यते ततः ।
इष्टोनेष्टहतश्चान्यो हीनः क्षेत्रात्तु वास्तवात् ॥ २९० ॥

इष्टोनेष्टेष्टयुग्घातस्तदर्थं क्षिप्यते त्विह ।
आधिक्यादिष्टघातस्य स पुनस्त्यज्यते ततः ॥ २९१ ॥

व्याख्या—1. A. C. छेद्यते 2. A. शोधनीया

3. C. गुण्यवृत्त्यायतं

4. C. omits this line and the next.

इत्थं संक्षेपतो न्यायो गुणकर्मणि दर्शितः ।
विस्तरेण तु तद्युक्ति गदितुं को नु शक्नुयात् ॥ २९२ ॥

[भागहरणवासना]

[1]भागात्मना भाज्यराशेः स्वीकारो हरणं मतम् ।
यथावृत्तो भागहारः शोध्यो भाज्यात् फलं तु तत् ॥ २९३ ॥

भाज्यस्यान्त्यपदात् प्राग्वद् हारावृत्तिर्विशोध्यते ।
तत्फलोद्धारसौकर्यान्नान्यत् तत्र नियामकम् ॥ २९४ ॥

तथा ह्यावृत्तिबाहुल्यं वेद्यं स्थानवशात् क्वचित् ।
अत एवात्र भाज्यान्त्याङ्कावधि स्थाप्यते हरः ॥ २९५ ॥

भाज्योपान्त्यावधित्वं वा हारस्यौचित्यतः क्वचित् ।
भाज्याद् यावतिथे स्थाने हारावृत्तिर्विशोध्यते ॥ २९६ ॥

लब्धं तावतिथे स्थाने तत्फलं स्थापयेद् बुधः ।
हारापसरणाल्लभ्यान्यधःस्थानि फलान्यपि ॥ २९७ ॥

हारावृत्तेरशोध्यत्वे शून्यं वा कुत्रचित् फलम् ॥ २९८ ॥

[वर्गकर्मवासना]

[2]वर्गे समद्विघातेऽत्र राशिः स्वेनैव हन्यते ।
रूपस्थानविभागेन तत्र खण्डद्वये कृते ॥ २९९ ॥

समद्विघातेन पृथक् तयोर्वर्गद्वये कृते ।
वर्गः समद्विघातात्मा कृत्स्नराशेर्न जायते ॥ ३०० ॥

खण्डौ द्वौ स्वेतरावृत्तौ हीयेते तत्कृतेर्यतः ।
खण्डयोरुभयोर्वर्गद्वये तत्र कृते पृथक् ॥ ३०१ ॥

तत्र खण्डद्वयाभ्यासः क्षिप्यते द्विगुणस्ततः ।
द्विघ्नैकखण्डगुणितः क्षेप्यः खण्डोऽथवाऽपरः ॥ ३०२ ॥

व्याख्या—1. Verses 293-98 are the same as in *Kriyākramakarī*, under *Līlāvatī*, 18, (edn., p. 22).

2. Verses 299-372 are the same as in *Kriyākramakarī*, under *Līlāvatī*, 21, (edn., pp. 29-36).

तत्र स्थानविभागेन वर्गे खण्डद्वये कृते ।
अन्त्यस्थानगतस्त्वेक उपान्त्यादिगतोऽपरः ॥ ३०३ ॥

यद्वाद्यस्थानगस्त्वेको द्वितीयादिगतोऽपरः ।
अन्त्याङ्कवर्गे प्राङ् न्यस्ते वर्गे वाद्याङ्कतः कृते ॥ ३०४ ॥

द्विघ्नमन्त्यस्तपदाभ्यस्तात् क्षिपेदङ्कानथापरान् ।
एवं वर्गविधिर्वर्ग्यराशेः खण्डद्वये कृते ॥ ३०५ ॥

यथा गुणस्य खण्डाभ्यां गुण्यः कृत्स्नो निहन्यते ।
खण्डौ गुणस्य हन्येते तथा कृत्स्नगुणेन च ॥ ३०६ ॥

खण्डद्वये तु प्रत्येकं कल्पिते गुणगुण्ययोः ।
द्वाभ्यां गुणस्य खण्डाभ्यां हन्तव्यौ गुणखण्डकौ ॥ ३०७ ॥

तत्र वर्गे स्वतुल्यौ द्वौ खण्डावन्यादृशौ परौ ।
[1]घातः स्वतुल्यखण्डाभ्यां तत्र वर्गद्वयात् तयोः ॥ ३०८ ॥

अन्यादृक् खण्डगुणनं तयोर्घातद्वयाद्[2] भवेत् ।
हन्तव्यौ गुणखण्डौ द्वौ गुणखण्डद्वयेन तत् ॥ ३०९ ॥

अन्त्याङ्क एकः खण्डः स्यादुपान्त्यादिरथापरः ।
उपान्त्यादेर्यदन्त्येन तस्योपान्त्यादिना च यत् ॥ ३१० ॥

गुणनं तदुपान्त्यादेर्द्विघ्नान्त्यहननाद् भवेत् ।
भिद्यते गुण्यगुणयोः परिवृत्या न तत्फलम् ॥ ३११ ॥

अन्त्यस्यान्त्येन चोपान्त्यादिनोपान्त्यस्य यो वधः ।
तावुभावुभयोर्वर्गकर्मणैव प्रसिध्यतः ॥ ३१२ ॥

न्यस्तेऽन्त्यवर्गे प्राग् द्विघ्नतत्पदेन हताः परे ।
उपान्त्याद्यास्ततस्तेषां वर्गः स्थाप्यः क्रमादिह ॥ ३१३ ॥

अन्त्यवर्गादुपान्त्यान्त्यघातस्थानं निकृष्यते ।[3]
अन्त्यान्त्यघातादन्त्योपान्त्याहतेरपकर्षतः ॥ ३१४ ॥

व्याख्या—1. A. खातस्य तुल्य; B.C. खातः स्वतुल्य
2. C. द्वयो for द्वयाद्
3. B. न युज्यते

उपान्त्यादेः कृतिस्तस्माद् घाततोऽपि निकृष्यते ।
घातस्थानं भवेन्मध्ये ततोऽन्त्योपान्त्यवर्गयोः ॥ ३१५ ॥

अतोऽत्र सर्ववर्गाणां स्थाने तु विषमे स्थितिः[1] ।
घातात्मनां तु खण्डानां समस्थाने स्थितिर्मता ॥ ३१६ ॥

अन्त्योपान्त्यक्रमो योज्य उपान्त्यादिष्वपि क्रमात् ।
अखण्डवर्गे तत्खण्डपरिकल्पनतः कृते ॥ ३१७ ॥

द्वौ वर्गौ खण्डयोर्द्वौ च संवर्गाविति ते स्थिताः ।
खण्डयोरुभयोर्वर्गौ तत्संवर्गद्वयान्वितौ ॥ ३१८ ॥

अखण्डराशेर्वर्गः स्यादित्येतद् युज्यते ततः ।
इह स्वल्पमहत्खण्डहृतिरल्पस्य वर्गतः ॥ ३१९ ॥

खण्डान्तराहतस्वल्पखण्डेनाभ्यधिको भवेत् ।
खण्डान्तरमहाखण्डस्याधिक्यं स्वल्पखण्डतः । ३२० ॥

तत्र स्वल्पः स्वनिहतस्तद्वर्गः प्रागुदीरितः ।
महाखण्डहतस्वल्पस्तत्संवर्गश्च कीर्तितः ॥ ३२१ ॥

खण्डान्तराहतः स्वल्पस्तद्घाते महदल्पयोः ।
अधिकोऽल्पकृतेस्तद्वत् खण्डान्तरहतो महान् ॥ ३२२ ॥

हीयते महतो वर्गाद्धतः खण्डान्तरघ्नयोः ।
खण्डयोरल्पमहतोर्भेदा भेदकृतेः समः ॥ ३२३ ॥

घातयोरुभयोर्योगाद्वर्गयोर्योगोऽतिरिच्यते ।
खण्डयोरुभयोर्वर्गौ ततो घातद्वयान्वितौ ॥ ३२४ ॥

चतुर्घ्नघातसंयुक्तखण्डान्तरकृतेः समौ ।
खण्डघातश्चतुर्घ्नोऽतो भेदवर्गान्वितः कृतिः ॥ ३२५ ॥

मूले मूलेन गुणिते वर्गराशिर्भवेदिह ।
इष्टोनेन हते तस्मिन्मूलमिष्टाहतं ततः ॥ ३२६ ॥

हीयते वर्धते त्विष्टहतमिष्टोनमेव च ।
इष्टोनमिष्टगुणितमधिकं यत्र वर्गतः ॥ ३२७ ॥

व्याख्या—1. A. B. स्थितौ

तत्रेष्टगुणमिष्टोनमूनं चेद्वर्ग एव सः ।
इह त्विष्टगुणं मूलं हीयते वर्गराशितः ॥ ३२८ ॥
इष्टाहतस्य मूलस्य तद्घ्नेष्टोनस्य चान्तरम् ।
क्षेप्यमिष्टोद्युग् घाते तदिहेष्टकृतेः समम् ॥ ३२९ ॥
इष्टवर्गयुतस्तस्मादिष्टोनयुतयोर्वधः ।
इष्टराशेर्भवेद्वर्ग इत्येतदुपपद्यते ॥ ३३० ॥
आद्यवर्गस्त्विह द्विघ्नतन्मूलेष्टवधान्वितः ।
इष्टवर्गेण च युतो वर्ग इष्टयुतस्य तत् ॥ ३३१ ॥
आद्यवर्गस्त्विह द्विघ्नमूलयुक्तः सरूपकः ।
एकोत्तराणामूर्ध्वोर्ध्वं वर्ग एकादितो भवेत् ॥ ३३२ ॥
एकादिद्विचयश्रेणीफलं वर्गस्ततो भवेत् ।
इष्टस्य वर्गो द्विघ्नेष्टहतान्येष्टयुतोमितः ॥ ३३३ ॥
अन्येष्टवर्गयुक्तौ तौ वर्गौ तद्योगभेदयोः ।
कुतश्चिद्वर्गतो द्विघ्नतन्मूलेष्टवधान्वितात् ॥ ३३४ ॥
इष्टवर्गयुतान्मूलं राशिरिष्टान्वितो भवेत् ।
द्विघ्नस्वमूलेष्टवधहीनाद् वर्गाच्च कस्यचित् ॥ ३३५ ॥
इष्टवर्गयुतान्मूलं राशिरिष्टान्वितस्ततः ।
द्विघ्नेष्टनिहतं द्विघ्नमूलं वर्गान्तरं ततः ॥ ३३६ ॥
चतुर्गुणेष्टं निहतं वा स्यादिष्टोनयुक्तयोः ।
इष्टयोर्मध्यगो राशिस्तदन्तरदलाहतः ॥ ३३७ ॥
चतुर्गुणोऽथवा द्विघ्नः कृत्स्नराश्यन्तराहतः ।
वर्गान्तरं भवेद्राश्योर्द्वयोरिति मनीषिणः ॥ ३३८ ॥
तद्युक्तिस्तादृशक्षेत्रदर्शनादवगम्यते ।
समकर्णं विधायाथ क्षेत्रं समचतुर्भुजम् ॥ ३३९ ॥
युक्तिं तु वर्गघातादेस्तत्र सम्यक् प्रदर्शयेत् ।
कुतश्चित्कोणतः स्वल्पखण्डान्ते पार्श्वयोर्द्वयोः ॥ ३४० ॥
दारयेत् प्रतिपार्श्वान्तं यथा खण्डचतुष्टयम् ।
तत्र तत्कोणसंयुक्तं स्वल्पतुल्यचतुर्भुजम् ॥ ३४१ ॥

प्रतिकोणगतं तस्मान्महाखण्डचतुर्भुजम् ।
वर्गक्षेत्रात्मकं चैतद् द्वयं कोणाश्रितं मिथः ॥ ३४२ ॥

चतुर्णामपि बाहूनां तुल्यत्वादुभयोरपि ।
अन्यकोणद्वयगते क्षेत्रे घातात्मके उभे ॥ ३४३ ॥

खण्डेन महता दैर्घ्यं तयोः स्वल्पेन विस्तृतिः ।
अखण्डवर्गस्तैः खण्डैश्चतुर्भिः परिपूर्यते ॥ ३४४ ॥

वर्गाभ्यां खण्डयोस्तत्र वर्गखण्डद्वयं कृतम् ।
घातात्मकं द्वयं द्विघ्नस्यैकस्यान्यवधादपि ॥ ३४५ ॥

खण्डद्वयाहृतिर्द्विघ्नी वर्गाभ्यां खण्डयोस्तयोः ।
युक्ता त्वखण्डवर्गः[1] स्यादित्येतद् युज्यते ततः ॥ ३४६ ॥

एष एव विधिः खण्डबहुत्वेऽप्यतिदिश्यताम् ।
खण्डान्तरान्तरे छिन्द्याद् वर्गक्षेत्रं महत् पुनः ॥ ३४७ ॥

यथा तत्खण्डयोर्दैर्घ्यं महाखण्डसमं भवेत् ।
एकोऽल्पखण्डविस्तीर्णः परः खण्डान्तरेण च ॥ ३४८ ॥

क्षेत्रं महत् तयोस्तत्र घातक्षेत्रद्वयाकृति ।
स्वल्पेन विस्तृतेर्दैर्घ्यात् त्रयाणां महतां तथा ॥ ३४९ ॥

यत्खण्डान्तरविस्तीर्णं महाखण्डेन चायतम् ।
तत्स्वल्पखण्डवर्गस्य सम्बध्यात् पार्श्वतस्तथा[2] ॥ ३५० ॥

यथास्य महता दैर्घ्यं विस्तारः स्वल्पसम्मितः ।
ततः खण्डान्तरकृतिः कोणे क्वाप्यस्य शिष्यते ॥ ३५१ ॥

तथापि नैव क्षेत्रं तत् घातक्षेत्रसमं यतः ।
मिथः श्लिष्टविस्तारदैर्घ्यपार्श्वद्वयैश्च तैः ॥ ३५२ ॥

कुर्यात् तथाविधं क्षेत्रं यत्खण्डचतुर्भुजम् ।
अपूर्णं तत्र तन्मध्ये खण्डान्तरचतुर्भुजम् ॥ ३५३ ॥

तथाविधं तत् प्रक्षेप्यं यत्तु पूर्वं पृथक्कृतम् ।
अखण्डवर्गक्षेत्रं तत् भवेत् समचतुर्भुजम् ॥ ३५४ ॥

व्याख्या—1. A. C. युक्तापखण्डवर्गः 2. A. ततः

घाते चतुर्गुणे खण्डान्तरवर्गसमन्विते ।
अखण्डराशेर्वर्गः स्यादित्येतदुच्यते ततः ॥ ३५५ ॥

वर्गक्षेत्रं तु यत्पूर्वमुक्तं समचतुर्भुजम् ।
तत्तु द्वितीयेनेष्टेन छिन्द्यादापादमस्तकम् ॥ ३५६ ॥

तथा सत्यायतचतुर्भुजं क्षेत्रद्वयं भवेत् ।
एत इष्टोनविस्तारस्तत्रान्योऽपीष्टविस्तृतिः ॥ ३५७ ॥

आद्यराशिसमायामावुभावपि तथाकृती ।
सम्बध्यान्महतः स्वल्पभुजे पार्श्वे तथाऽपरम् ॥ ३५८ ॥

स्वल्पेष्टवर्गस्तत्कोणे यथा चाप्यवशिष्यते ।
तं विनेष्टोनयुग्राश्योर्घातक्षेत्रस्य दर्शनात् ॥ ३५९ ॥

इष्टोनयुतयोर्घातो हीन इष्टकृतेस्ततः ।
इष्टोनयुग्राशिवध इष्टवर्गयुतस्ततः ॥ ३६० ॥

अखण्डेष्टकृतिः स्यादित्येतदप्युपपद्यते ।
वर्गयोगो द्विगुणितो योगवर्गात्तथाधिकः ॥ ३६१ ॥

राश्यन्तरस्य वर्गेणेत्येतदप्यत्र लक्ष्यते ।
वर्गौ द्वौ खण्डयोर्घातौ द्वावखण्डकृतौ स्थिताः ॥ ३६२ ॥

वर्गद्वयं भेदकृत्या हीनं घात[1]द्वयादपि ।
योगवर्गे भवेद्वर्गद्वयं घातद्वयं द्वयोः ॥ ३६३ ॥

वर्धते भेदवर्गेण द्विघ्ना वर्गयुतिस्ततः ।
इतीदमुक्तमार्गेण क्षेत्रकल्पनतः स्थितम् ॥ ३६४ ॥

द्विघ्नभेदहतः स्तल्पो भेदवर्गस्तथा द्वयोः ।
यथा योगान्तराभ्यासो राश्योर्वर्गान्तरं भवेत् ॥ ३६५ ॥

राश्योर्भेदेन भेदोऽपि द्विघ्नोऽल्पेऽप्यत्र[2] हृन्यते ।
भेदान्वितोऽल्पः स महान् योगः स्वल्पयुतश्च सः ॥ ३६६ ॥

व्याख्या—1. D. breaks in the middle of a leaf, the rest of the leaf being left blank. Also it has a confused ending : हीनं म घातत

2. C. द्विघ्नाल्पोप्यत्र

राश्योर्योगान्तराभ्यासो वर्गभेदस्ततो मतः ।
राश्योर्योगान्तराभ्यासे कुर्यात् खण्डद्वयं पृथक् ॥ ३६७ ॥

भेदाहतो महानेकस्तथान्योऽल्पस्तदाहतः ।
महाखण्डावपि तथा कुर्यात् क्षेत्रद्वयं पृथक् ॥ ३६८ ॥

स्वल्पो भेदाहतोऽत्रैको भेदवर्गस्तथापरः ।
पार्श्वयोः स्वल्पवर्गस्य भेदः स्वल्पवधद्वयम् ॥ ३६९ ॥

सन्दध्यात् भेदवर्गं च तत्स्वतं कोणगं तथा ।
अखण्डवर्गक्षेत्रं तत् भवेद् खण्डचतुष्कतः ॥ ३७० ॥

एकादिद्विचयानां यत्फलं सङ्कलितात्मकम् ।
तैराद्यपार्श्वद्वितयसुश्लिष्टैस्तरोत्तरम् ॥ ३७१ ॥

गच्छतुल्यचतुर्बाहौ वेद्यं वर्गफलं तु तत् ॥ ३७२ ॥

[वर्गमूलवासना]

[1]एकादिद्विचयश्रेण्यां भवेदन्त्यफलं तु यत् ।
तदेव समुखं गच्छार्धघ्नं वर्गफलं भवेत् ॥ ३७३ ॥

तथा ह्यन्त्यधनं द्विघ्नात् गच्छादेकोनितं भवेत् ।
मुखादुपरि सर्वेषां पदानां द्विगुणत्वतः ॥ ३७४ ॥

मुखयोगेन तेऽप्यन्त्यधनसम्पादनादपि ।
तत्रैकस्य मुखस्यापि क्षेपाद् द्विघ्नं तु तत्पदम् ॥ ३७५ ॥

[2][द्वितीयोपान्त्ययोर्योगाद्] भूयोऽप्येतत् पदद्वयम् ।
एवं तदन्तर्गतेषु मुहुर्योगाद् द्वयोर्द्वयोः ॥ ३७६ ॥

क्षेत्रं पदार्धविस्तारं ततो द्विघ्न[3]पदायतम् ।
आयामं मध्यतश्छित्त्वा पार्श्वयोर्योजयेत्तु तौ ॥ ३७७ ॥

व्याख्या—1. Verses 373-84 are the same as in *Kriyākramakarī* under *Līlāvatī* 23, verses 20b-31, (edn., pp. 43-44.)

2. Mss. corrupt : A.C. द्वितीयो वाक्ययोर्योगात्; B. द्वितीयोयाम्ययोर्योगात्

3. A. विष्णु for द्विघ्न

वर्गक्षेत्रं भवेदेतत् ततो गच्छचतुर्भुजम् ।
एकस्य वर्गो रूपेण मुखेनैव समो भवेत् ॥ ३७८ ॥

द्व्यादीनां द्विचयश्रेणिक्षेत्रं सर्वघनैः समः ।
योगान्तराहतिर्वर्गान्तरं यस्मात्प्रदर्शितम् ॥ ३७९ ॥

रूपोत्तराणां योगाः स्युः द्व्यधिकाः पूर्वपूर्वतः ।
आद्यो योगो ययोस्तस्माद् द्वितीयो रूपयुक्तयोः ॥ ३८० ॥

योग इत्याद्ययोगात् स द्वितीयोऽभ्यधिको न किम् ।
रूपोत्तराणां सर्वेषामेकमेवान्तरं भवेत् ॥ ३८१ ॥

योगान्तराहतिस्तस्मादूर्ध्वोर्ध्वं द्व्यधिका भवेत् ।
योगान्तराहतेर्वर्गान्तरत्वं दर्शयिष्यते ॥ ३८२ ॥

वर्गो वर्गान्तरयुतः स्वोर्ध्ववर्गो भवेत् स्फुटम् ।
रूपादिद्विचयश्रेणी[1]फलान्यत्र पृथक् पदे ॥ ३८३ ॥

वर्गान्तराणि, तद्योगो भवेद्वर्गफलं ततः ।
ततश्चतुर्भुजाद्वर्गान्मूलमेकभुजोन्नयः[2] ॥ ३८४ ॥

[वर्गमूलकर्मवासना]

[3]व्याख्यातमूलकर्मापि युक्त्यैवयाद्वर्गकर्मणा ।
किन्तु यद्विकृतिर्वर्गस्तन्मूलं स्वपदस्थितिः ॥ ३८५ ॥

अतो वर्गात् परावृत्य गणितान्मूलमिष्यते ।
युतौ शुद्धिर्युतिः शुद्धौ, गुणो हारे, हरे गुणः ॥ ३८६ ॥

वर्गे पदं, पदे वर्गः परावृत्तौ प्रकल्प्यते ।
स्थानापकर्षे चोत्कर्षस्तदुत्कर्षेऽपकृष्टता ॥ ३८७ ॥

इष्टं घने च तन्मूलं, घनमूले घनस्तथा ।
इत्थं योज्यः परावृत्तौ यथोद्देशं विपर्ययः ॥ ३८८ ॥

व्याख्या—1. B. श्रेढी 2. B. भुजोन्नतः

3. Verses 385-97 are the same as in *Kriyākramakarī*, verses 8-20, under *Līlāvatī*, 23, (edn., p. 42).

कार्यकारणभावाख्यः सम्बन्धो वर्गमूलयोः ।
अतो हेतुपदेनापि क्वचिन्मूलमिहोच्यते ॥ ३८९ ॥

इह केनचिदावृत्तं कस्याप्यभ्यासजं फलम् ।
अपवृत्तं तु कस्यापि केनचिद्विहृतं फलम् ॥ ३९० ॥

वर्गमूलेऽन्त्यविषमाद् वर्गशुद्धिर्विधीयते ।
विशुद्धवर्गमूलेन द्विघ्नेनोपान्त्यतः समात् ॥ ३९१ ॥

यावल्लब्धं फलं तस्य वर्गः शोध्यस्तदाद्यतः ।
वर्गशुद्धया त्वयावन्त्याद् विषमाद् यदनन्तरम् ॥ ३९२ ॥

तत्पदाद् भागहरणे[1] नियमो न तु सर्वदा ।
किन्तु सम्भव एवैतत् शून्यमेवान्यथा फलम् ॥ ३९३ ॥

शोधयेत् भागहारेण लब्धवर्गं तदाद्यतः ।
भागहारः समस्थानाद् युतः कर्तुं न शक्यते ॥ ३९४ ॥

तदा तदाद्यविषमस्थानाद्वर्गो न शोध्यते[2] ।
यतो लब्धफलस्यैव शोध्यत्वं नेह तत्फलम् ॥ ३९५ ॥

किन्तु यस्मात्समस्थानाद् भागहारावधिः कृतिः ।
तदाद्याद् विषमस्थानाल्लब्धवर्गो विशोध्यताम् ॥ ३९६ ॥

इत्येष नियमो वेद्यो वर्गमूलाख्यकर्मणि ॥ ३९७ ॥

[वर्गमूलकर्म]

वर्गयोगपदे साध्ये तयोरल्पस्य वर्गतः ।
द्विघ्नेन महताप्तस्य कृतिं शेषाद् विशोधयेत् ॥ ३९८ ॥

तत्फलं द्विगुणीकृत्य क्षिपेत्तत्रैव हारके ।
आभाज्यान्तमिदं कर्म कार्यं हारदलं पदम् ॥ ३९९ ॥

वर्गयोगपदे साध्ये द्वयोरल्पस्य वर्गतः ।
द्विघ्नेन महता लब्धफलयुक्तेन यद् हृतम् ॥ ४०० ॥

व्याख्या—1. A. पादहरणे; C. पादहारेण
2. B. वर्गो विशोध्यताम्

[1]तल्लब्धयुतहाराधं वर्गयोगपदं भवेत् ।
वर्गान्तरपदे साध्ये द्वयोरल्पस्य वर्गत: ॥ ४०१ ॥

द्विघ्नेन महता लभ्यफलहीनेन यद् हृतम् ।
ततो लब्धोनहारार्धं वर्गान्तरपदं भवेत् ॥ ४०२ ॥

[दशाविधय:]

[2]राश्योर्योगोभिदा घातो[3] वर्गयोगस्तदन्तरम् ।
एष द्वाभ्यां दशाविधमितरानयनं भवेत् ॥ ४०३ ॥

योगो भेदादिसंयुक्तो भेदो घातादिना तथा ।
स्वोत्तरोत्तरसंयुक्ताश्चैवं घातादय: परे ॥ ४०४ ॥

राशिद्वयं पृथक्कुर्युर्यथा तत्तु[4] तथोच्यते ।
योगभेदयुते द्विघ्नो महानल्पस्तदूनिते ॥ ४०५ ॥

अर्धीकृतौ तु तौ स्यातां राशी द्वौ महदल्पकौ ।
राश्योश्चतुर्गुणे घाते त्यक्ते योगस्य वर्गत: ॥ ४०६ ॥

शिष्यन्तेऽन्तरवर्गोऽत्र तन्मूलं स्यात्तदन्तरम् ।
योगान्तराभ्यां राशी द्वौ पृथक्कार्यौ तु पूर्ववत् ॥ ४०७ ॥

योगवर्गाद्वर्गयोगे त्यक्ते द्विघ्नस्तयोर्वध:[5] ।
तदूनिताद्वर्गयोगान्मूलं राशिद्वयान्तरम् ॥ ४०८ ॥

वर्गान्तराद्योगभक्तो भेदस्तद्विहृतोऽपर: ।
योगान्तराहतेर्वर्गान्तरत्वं दर्शितं यत: ॥ ४०९ ॥

भेदकृत्याधिको योग[6]वर्गो घाताच्चतुर्गुणात् ।
भेदवर्गयुतात्तस्मान्मूलं राश्योर्युतिर्भवेत् ॥ ४१० ॥

व्याख्या—1. C. Hap. om. of the next three lines.

2. Some of the verses from 403 are very similar to certain verses in *Kriyākramakarī* under *Līlāvatī*, 59, (edn. p. 109), where 21 problems are treated while only 10 problems are treated here.

3. A.B. भिघातो 4. A. यथा कर्तु

5. A. निघ्नस्तयोरध: 6. A. B. C. योगो

भेदकृत्याधिको वर्गयोगो घातद्वयाद्विह[1] ।
घातस्ततो वर्गयोगाद् भेदवर्गोनिताद्दलम् ॥ ४११ ॥

राश्योर्योगान्तराभ्यासो वर्गभेदो यतो भवेत् ।
वर्गान्तराद्योगभक्तो भेदो भेदोद्धृतोऽपरः ॥ ४१२ ॥

द्विघ्नघातयुतो वर्गयोगो योगकृतिर्भवेत् ।
तदूनितो वर्गयोगो भेदवर्गस्तयोर्मतः ॥ ४१३ ॥

चतुर्भिर्गुणितो घातो भेदवर्गेण संयुतः ।
योगवर्गस्तयोः स्यादित्येतद्युक्तिविदां मतम् ॥ ४१४ ॥

वर्गान्तरस्य वर्गेण घातवर्गश्चतुर्गुणः ।
युक्तस्तद्योगवर्गवर्गोवीत्युपपद्यते ॥ ४१५ ॥

यतो मूलेन सम्पाद्यं तद्वर्गेणापि कल्प्यते ।
किन्तु वर्गः फलस्यात्र फलराशिस्तु लभ्यते ॥ ४१६ ॥

[भागजातिवासना]

[2]यावद्धा छिद्यते रूपं छेदस्तावानिहोच्यते ।
[विभाग][3]व्यक्तयोऽप्यंशास्तवियता न तु क्वचित् ॥ ४१७ ॥

छेदांशानां हि[4] नानात्वं दृश्यते विषयान्तरे ।
उद्देशवशतः[5] क्वापि नानात्वं कृत्रिमं क्वचित् ॥ ४१८ ॥

कर्मक्रमवशाद्भिन्नगुणवर्गघनादिषु ।
अंशानां भिन्नहाराणां योगविश्लेषसिद्धये ॥ ४१९ ॥

समच्छेदत्वमिष्टं स्यादासामञ्जस्यमन्यथा ।
पूर्णं पूर्णेन संयोगाद् यथा संख्यान्तरं व्रजेत् ॥ ४२० ॥

व्याख्या—1. A. द्वयादि यः

2. Verses 417-30 are closely similar to *Kriyākramakarī*, verses 1-13, under *Līlāvatī* 32, (edn., pp. 64-65).

3. A. B. विभङ्ग

4. A. छेदांशानिह

5. A. तदुद्देशतः

न पादेन न चार्धेन न पादोनेन योगतः ।
पादार्धाद्यधिकत्वेन व्यवहारप्रसङ्गतः ॥ ४२१ ॥

यादृक्छेदोंऽशकस्तस्य तादृक्छेदांशयोगतः ।
संख्यान्तरोपपत्तिः स्यादसमञ्जस्यतोऽन्यथा ॥ ४२२ ॥

पादपञ्चमसंयोगाद् द्वौ न तुर्यौ न पञ्चमौ ।
तुल्याष्टमांशयोरेवं न संयोगे द्वयोर्द्वयम्[1] ॥ ४२३ ॥

अथ रूपचतुर्थस्य पञ्चमांशः कृतो यदा ।
पञ्चमांशोऽपि वा स्वीयचतुर्थांशः कृतो भवेत् ॥ ४२४ ॥

अन्योन्यच्छेदगुणनात्तत्र च्छेदांशयोर्द्वयोः ।
तदा तौ रूपविंशांशौ कृतावेवाऽविवादतः ॥ ४२५ ॥

तौ ततोंऽशौ समच्छेदौ मिथो योगान्तरक्षमौ ।
यादृशो नियमो दृष्टो ययोश्छेदांशयोरिह ॥ ४२६ ॥

एकेन हृतयोस्तादृङ्नियमो न तु हीयते ।
तादृशश्च गुणोऽन्योन्यच्छेदेनैवांशहारयोः ॥ ४२७ ॥

अन्योन्यच्छेदगुणितौ ततः छेदांशकावुभौ ।
समच्छेदीकृतौ स्यातां योगभेदक्षमौ ततः ॥ ४२८ ॥

योगभेदौ मिथः कार्यौ बहूनां च सवर्णनात् ॥ ४२९ ॥

इति ।

[प्रभागजातिवासना]

[2]भागप्रभागतद्भागसंवर्गो भाग इष्यते ।
छेदानामपि सर्वेषां संवर्गस्तस्य हारकः ॥ ४३० ॥

प्रभागजातौ भागास्ते स्युः सवर्णीकृता यतः ।
तदेतद्भिन्नगुणनात् पृथग्वक्तुं न पार्यते ॥ ४३१-३२ ॥

व्याख्या—1. B. द्वयोर्द्वयोः स

2. Verses 430-38 are the same as *Kriyākramakarī*, verses 1-8, under *Līlāvatī*, 33, (edn., p. 68).

तत्राप्यंशाहतिश्छेदघातभक्ता फलं यत: ।
तथापि भिन्नरूपत्वात् गुणनस्य सवर्णनात् ॥ ४३३ ॥

सवर्णनं च गुणनं पृथगेवात्र लक्षितम् ।
ननु रूपाद्विभक्तोंऽशो भाग: केनापि कथ्यते ॥ ४३४ ॥

भागत: केनचिद्भिन्न:[1] प्रभाग: कथ्यते कथम् ।
तत्र तच्छेदसंवर्ग: छेद[2]स्तस्योपपद्यते ॥ ४३५ ॥

भागप्रभागसंवर्ग: प्रभागस्तु कथं भवेत् ।
भागव्यक्तेर्यदैकस्या:[3] प्रभागस्तत्र कल्प्यते ॥ ४३६ ॥

तत्र प्रभागस्तूद्दिष्ट: च्छेद: च्छेदद्वयाहति: ।
यदा बहूनां भागानां प्रभाग: परिकल्पित: ॥ ४३७ ॥

भागप्रभागसंवर्ग: प्रभाग: कल्पितस्तदा[4] ॥ ४३८ ॥

इति ।

[भागानुबन्ध-भागापवाह-वासना]

[5]भागच्छेदहतं रूपं भागैर्याति सवर्णताम् ।
प्रभागच्छेदनिहतास्ते प्रभागै: सवर्णिता: ॥ ४३९ ॥

एवं प्रभागतद्भागच्छेदैर्भागावयो हता: ।
प्रभागाद्यै: सवर्णत्वं व्रजन्त्येवं[6] मुहुर्मुहु: ॥ ४४० ॥

योगभेदक्षमा भागा: प्रभागाद्यै: सवर्णिता: ।
यदा रूपादिषु बहुष्वेको भागप्रसादक: ॥ ४४१ ॥

यदा तूद्दिष्टरूपेषु भाग: कृत्स्नेषु कल्प्यते ।
भागच्छेदेन रूपाणि हन्याच्छेदं च तद्गतम् ॥ ४४२ ॥

ततो भागान् यथोद्देशं प्रक्षिपेदथवा त्यजेत् ।
तद्वत् प्रभागच्छेदेन भागच्छेदावुभौ हतौ ॥ ४४३ ॥

व्याख्या – 1. C. केनचित् छन्न: 2. A. B फलं for छेद:
3. A. B. यदेकस्य 4. A. तत:
5. Verses 439-58 are the same as *Kriyākramakarī*, verses 1-20, under *Līlāvatī*, 36, (edn., pp. 73-74).
6. A. B. व्रजन्त्येव

प्रभागानपि भागेषु क्षिपेद्वा ततस्त्यजेत् ।
यथा तूद्दिष्टरूपेषु भागः कृत्स्नेषु कल्प्यते ॥ ४४४ ॥

भागेष्वपि यथा सर्वे प्रभागस्य प्रसावकाः[1] ।
भागच्छेदेन रूपाणां गुणनं यत्र सूचितम् ॥ ४४५ ॥

तत्र च्छेदेन रूपाणामावृत्तिः क्रियते ततः ।
रूपे च्छेदविभक्ते तु योंऽशस्ताबानिहांशकः ॥ ४४६ ॥

ततो रूपस्य पूर्णत्वं तदंशैश्छेदसम्मितैः ।
रूपाण्यंशसवर्णानि तच्छेदनिहतान्यतः ॥ ४४७ ॥

भवन्ति योगविश्लेषयोग्यत्वं तेन कल्पितम् ।
भागप्रभागेष्वप्येवं वेद्यस्त्वंशांशिनीः क्रमः ॥ ४४८ ॥

"छेदघ्नरूपेषु लवा धनर्ण"मिति तद्वचः ।
(लीलावती, ३४)
उपपद्येत तत्सर्वं योगविश्लेषसिद्धये ॥ ४४९ ॥

रूपाणामथ सर्वेषां भागानां वांशकल्पने ।
छेदसंवर्गतुल्याः स्तुश्छेदास्तत्रांशकाः पुनः ॥ ४५० ॥

रूपाणि स्वांशयुक्तोनस्वाधच्छेदहतानि[2] तु ।
सर्वेषामपि रूपाणां भागानां वांशकल्पने ॥ ४५१ ॥

सर्वेषां स्वांशयुक्तोनस्वाधश्छेदेन गुण्यता ।
गुण्यात् केनापि गुणिताद् गुणांशः शोध्यते यतः[3] ॥ ४५२ ॥

तत्र तद्व्यक्तिहीनेन गुण्यं हन्याद् गुणेन वा ।
गुणावृत्ताद् यतो गुण्यात् तदावृत्तिर्विशोध्यते ॥ ४५३ ॥

तद्व्यक्त्यूनगुणाभ्यस्ते तामावृत्तिं विना भवेत् ।
गुण्ये गुणांशयुक्तेऽस्मिन् गुणयेत्तद्युतेन तम् ॥ ४५४ ॥

अतो [निरन्तराधस्थ्य][4] हारेणोर्ध्वहरे हते ।
उद्दिष्टांशाधिकोनेन स्वोर्ध्वांशं गुणयेत्ततः ॥ ४५५ ॥

व्याख्या—1. A. प्रसावताम्　2. A. हृतानि　3. A. ततः
4. A. निरन्तराधस्य ; B. निरन्तराधस्व; C. निरन्तरा यस्य

भागप्रभागेषूद्दिष्टेष्वेवं कुर्यान्मुहुर्मुहुः ।
अत्रेष्टं कल्पयित्वैकं छेदसंवर्गताडितम् ॥ ४५६ ॥

उद्दिष्टभागतद्भागक्षेपशुद्ध्यादिरत्र तु ।
तत्र लब्धेन निहतं दृष्टं छेदवधोद्धृतम् ॥ ४५७ ॥

एवं लब्धे भवेत्प्रष्टुरिष्टो राशिर्न संशयः ॥ ४५८ ॥

[भिन्नगुणनवासना]

[1]यदुक्तं गुणकारेण गुण्यस्यावर्तनं गुणे ।
यावत्यो व्यक्तयो गुण्ये तावद्धा गुणकल्पनम् ॥ ४५९ ॥

गुणकारे प्रतिव्यक्ति गुण्यराशिं प्रकल्पयेत् ।
गुण्यराशौ प्रतिव्यक्ति गुणं वा परिकल्पयेत् ॥ ४६० ॥

इतीमौ द्वौ प्रकारौ स्तः संवर्गे गुणगुण्ययोः ।
अर्धत्र्यंशादिरूपेण च्छिन्ने गुण्ये गुणेऽपि वा ॥ ४६१ ॥

तेन च्छेदेन हर्तव्यः संवर्गो गुणगुण्ययोः ।
भागरूपः स्वयं गुण्यो भागात्मैव गुणाहतः ॥ ४६२ ॥

भागेन गुणितो गुण्यो भागरूपो भवेत् स्वयम् ।
छेदेत च्छिद्यमानोंऽशो रूपाद्भागो भवेद्यतः ॥ ४६३ ॥

गुण्यस्य गुणकस्यापि द्वयोर्भागात्मना स्थितौ ।
तद्घातच्छेदघातेन हर्तव्यो गुणगुण्ययोः ॥ ४६४ ॥

गुण्यते यादृशो गुण्यो भागो रूपात्मकोऽपि वा ।
तादृक्स्वभावस्तस्यैव गुणघ्नस्य न हीयते ॥ ४६५ ॥

भागेन यद्वा रूपेण गुणकारेण यो हतः ।
गुण्यः स गुणकारस्य तं स्वभावं न मुञ्चति ॥ ४६६ ॥

यतो गुणेन शून्येन गुणितः शून्यतां व्रजेत् ।
शून्यं रूपादिगुणितं तद्वच्छून्यत्वमाप्नुयात् ॥ ४६७ ॥

व्याख्या—1. Verses 459-71 are the same as *Kriyākramakarī*, verses 1-13, under *Līlāvatī*, 39, (edn., pp. 79-80).

एवं स्थिते भागरूपे गुण्ये यद्वा गुणे सति ।
स्वकच्छेदेन हर्तव्यस्तत्संवर्गो द्वयोः पुनः ॥ ४६८ ॥
भागात्मनोः स संवर्गो भाज्यच्छेदवधेन हि ।
'अंशाहतिश्छेदवधेनोद्धृते'त्युदितं ततः ॥ ४६९ ॥
(लीलावती, ३९)

भागवर्गे ततो भागे स्वेनैव गुणिते सति ।
च्छेदस्य वर्गच्छेदः स्यात् घने भागस्य तद्घनः[1] ॥ ४७० ॥
स्पष्टीकरिष्यते चैतद्भिन्नवर्गे घनेऽपि च ।
वर्गं घनं च छेदस्य तच्छेदं वर्शयिष्यता ॥ ४७१ ॥

[भिन्नभागहारवासना]

[2]गुण्ये गुणेऽथवा छिन्ने तच्छेदो भाजको यथा ।
तथैव भाज्ये भिन्नेऽपि तच्छेदो भाजको भवेत् ॥ ४७२ ॥
संवर्गो गुण्यगुणयोः प्रायो भाज्यो भवेद्यतः ।
भिन्ने गुणेऽथवा गुण्ये तच्छेदो भाजको यथा ॥ ४७३ ॥
भिन्नयो रूपयोश्छेदसंवर्गो भाजकस्ततः ।
संवर्गो गुण्यगुणयोर्भाज्योऽन्यो वा भवेद्यदा ॥ ४७४ ॥
भाज्यच्छेदस्य हारत्वं तदा भाजकवत् स्थितम् ।
भाज्यो भागात्मकश्छेदभक्तः पूर्णो भवेद्यतः ॥ ४७५ ॥
पूर्णेन भागहारेण भाज्यः पूर्णो विभज्यताम् ।
छिन्नः केनापि भाज्योऽत्र हर्तव्योऽन्येन चेत् पुनः ॥ ४७६ ॥
तदा तद्धारसंवर्गः कृत्स्नभाज्यस्य भाजकः ।
अतो भागात्मके भाज्ये तच्छेदो भाजकाहतः[3] ॥ ४७७ ॥

व्याख्या—1. C. घनम्

2. Verses 472-86 are the same as *Kriyākramakarī*, verses 1-16, under *Līlāvatī*, 41, (edn., pp., 82-83).

3. B. भाजको हृतः

भागहारो मतो येन भाज्योंऽशात्मा विभज्यते ।
भागहारेऽपि भागात्मन्यथ भाज्याद्विशोधिते ।। ४७८ ।।
पूर्णरूपात् स यावद्धा च्छिन्नो भागात्मतां गतः ।
तावता गुणितं भागाहारे पूर्वं फलं भवेत् ।। ४७९ ।।
व्यक्तीनां भाज्यनिष्ठानां पूर्णरूपतया स्थितेः ।
भागात्मना भागहारव्यक्तीनां च व्यवस्थितेः ।। ४८० ।।
स्वच्छेदविहृतस्यैव भाज्यव्यक्तिसमत्वतः ।
अन्यथा भागहारस्य स्वच्छेदगुणितत्वतः ।। ४८१ ।।
तच्छेदगुणितो भाज्यस्तेन सावर्ण्यमृच्छति[1] ।
हृतयोर्हतयोर्वापि राशिनैकेन तु द्वयोः ।। ४८२ ।।
सम्बन्धः प्राक्तनो नैव हीयते हारभाज्ययोः ।
यावद्भिरथवा भागैर्भागहारस्य पूर्यते ।। ४८३ ।।
भाज्यरूपं ततस्त्यक्ते भागहारेंऽशकात्मके ।
पूर्णभागात्मकव्यक्तौ रूपत्वस्यानु[2]वर्तनात् ।। ४८४ ।।
अविशेषेण रूपेभ्यो भागानां च विशोधनात् ।
छेदावृत्तेर्भागहारो विशुद्धोंऽशात्मको भवेत् ।। ४८५ ।।
अतश्छेदेन गुणनं फलानामिष्यते बुधैः ।। ४८६ ।।

इति ।

[भिन्नवर्गघनवासना]

[3]भिन्नयोर्गुण्यगुणयोः संवर्गे छेदयोर्वधः ।
छेदः स्यादिति यद्भिन्नगुणकर्मणि दर्शितम् ।। ४८७ ।।
समद्विघातरूपेऽस्मिन् वर्गेऽप्येतत्समं भवेत् ।
स्वच्छेदेनांशितो गुण्यो वर्गे स्वेनैव हन्यते ।। ४८८ ।।

व्याख्या—1. A. सावर्ण्यमिच्छति

2. A.B. रूपत्वस्वानु

3. Verses 487-94 are the same as *Kriyākramakarī*, verses 1-8, under *Līlāvatī*, 43, (edn., p. 86).

छेदवर्गस्तु तच्छेदच्छिन्नत्वाद् गुणगुण्ययोः ।
वर्धते गुणनाद् गुण्यो रूपव्यस्तात्मके गुणे ॥ ४८९ ॥

भागात्मनि गुणे च्छेदभक्तः पूर्णो भवेत् ततः ।
गुण्ये भागे गुणव्यक्त्या वृद्धच्छेदोद्धृतस्तथा ॥ ४९० ॥

द्वयोर्भागात्मनोर्गुण्यगुणयोर्घाततस्तयोः ।
तच्छेदद्वयसंवर्गच्छिन्नो भाज्यो भवेत् स्फुटः ॥ ४९१ ॥

वर्गे स्वेनैव भागस्य गुणनात् तद्घनेऽपि च ।
वर्गो घनश्च[1] च्छेदस्य तच्छेदत्वेन कल्प्यते ॥ ४९२ ॥

मूले तु वर्गघनयोरुभयोर्मूलकर्मणा ।
स्वावृत्तिपरिहारात्तु छेदः स्यात् केवलः स्फुटः ॥ ४९३ ॥

अतो भागात्मनां वर्गघनयोरिष्टयोर्द्वयोः ।
वर्गो घनश्च च्छेदौ स्तो मूले मूलं च कल्पितम् ॥ ४९४ ॥

इति ।

[भागानुबन्धवासना]

[2]अन्त्यस्थानाङ्कवर्गो यो यश्चोपान्त्याङ्कसंश्रितः ।
तयोः संवर्गरूपोऽन्यो द्विघ्नस्तन्मध्यसंश्रितः ॥ ४९५ ॥

स्थानद्वितयसम्बन्धादुभयोर्गुणगुण्ययोः ।
अन्त्याङ्कवर्ग उभयोरन्त्यस्थानसमाश्रितः ॥ ४९६ ॥

उपान्त्यस्थानवर्गोऽपि तथोपान्त्यसमाश्रितः ।
वर्गद्वययुते घातद्वितये खण्डयोर्द्वयोः ४९७ ॥

अखण्डराशेर्वर्गः स्यादिति प्रागेव चर्चितम् ।
"खण्डद्वयस्याभिहतिर्द्विघ्नी"त्युक्तवतामुना ॥ ४९८ ॥

(लीलावती, २०)

व्याख्या—1. A. घनस्य

2. Verses 495-99 are the same as *Kriyākramakarī*, verses 1-5 under *Līlāvatī*, 44, (edn., p. 89).

[अहर्गणेन ग्रहमध्यमाः]

द्युगणाद् भगणाभ्यस्ताद् भूदिनैर्भगणा गताः ॥ २६ ॥

द्वादशघ्नाच्च तैरेव शेषादाप्ताश्च राशयः ।
मुहुश्च त्रिंशता षष्ट्या निघ्नाद् भागादयश्च तैः ॥ २७ ॥

कल्यादिध्रुवयुक्तं तन्मध्यं स्यादुदयोद्भवम् ॥ २८a ॥

वर्गस्थानानि सर्वेषामवर्गान्तरितान्यतः ।
भागप्रभागवर्गेष्वप्ययमेव विधिर्मतः ॥ ४९९ ॥

इति ।

[ग्रहमध्यमानयनम्]

द्युगणादित्यादि (I. 26b-28a)—

[त्रैराशिकवासना]

[1]प्रमाणतत्फलेच्छाख्यास्त्रयो यस्य तु कारणम् ।
इच्छाफलस्य, सोऽयं स्यात् त्रिराशिरुपचारतः ॥ ५०० ॥

कार्यकारणभावाख्यः[2] सम्बन्धो यत्र विद्यते ।
त्रैराशिकमिति प्रोक्तं गणितं तत्प्रयोजनम् ॥ ५०१ ॥

तत्र प्रमाणं स्वफलव्याप्तधर्मसमन्वितम् ।
फलं तद् व्यापकं चेच्छाराशिरिष्टफलाश्रयः ॥ ५०२ ॥

इच्छाफलाश्रिताप्येतदाश्रयोऽत्रोपचर्यते ।
एभिस्त्रिभिश्च सम्भूय ज्ञेयमिच्छागतं फलम् ॥ ५०३ ॥

त्रिभ्योऽत्र येभ्यः केभ्यश्चित् ज्ञातं त्रैराशिकं न तत् ।
फलव्याप्तस्य धर्मस्य प्रमाणे तत्फलस्य च ॥ ५०४ ॥

व्याख्या—1. Verses 500 ff. have several verses in common with *Krīyākramakarī*, verse 1 ff., under *Līlāvatī*, 89 (edn., pp. 204-9). 2. A. भावस्य

भूयोदर्शनतस्तर्कानुविद्धाद् व्याप्तिनिर्णयः ।
ननु प्रमाणं सर्वत्र फलव्याप्तं प्रतीयते ॥ ५०५ ॥

न पुनस्तद्गतः कश्चित्तद्धर्मोऽनुपलम्भतः ।
सत्यं, तथापि धर्मोऽसौ विवेच्यो न्यायचक्षुषा ॥ ५०६ ॥

प्रमाणं यादृशं यत्र तत्फलं तत्र तादृशम् ।
इति निर्णीयते व्याप्तिर्मुहुर्दर्शनतस्तयोः ॥ ५०७ ॥

प्रमाणं तत् स्वधर्मस्य फलव्याप्तेर्निदर्शनम् ।
यत्र प्रमाणसारूप्यं दृश्यते वस्तुनि क्वचित् ॥ ५०८ ॥

फलं तत्रानभिव्यक्तमपि कल्प्यं प्रमाणवत् ।
सारूप्यं चानुवृत्तेन तयोर्धर्मेण कल्प्यते ॥ ५०९ ॥

तथाहि स्वफलव्याप्तः क्वचिद् यो धर्म आस्थितः ।
स एवान्यत्र दृष्टश्चेत् तस्मिंस्तदनुमापकः ॥ ५१० ॥

प्रमाणं तत्फलव्याप्तधर्मस्यास्य फलस्य च ।
व्याप्तिसंवेदनस्थानमिच्छाभीष्टफलाश्रयः ॥ ५११ ॥

फले [यद्यपि][1]गन्तव्या तत्रेच्छायां प्रमाणवत् ।
प्रमाणधर्ममिच्छायां तदर्थं तत्फलान्वितम् ॥ ५१२ ॥

पक्षधर्मतया ज्ञात्वा फलं तत्रानुमीयते ।
प्रयाणसंख्या गमिता[2] फलसंख्या तु गम्यते ॥ ५१३ ॥

प्रमाणसंख्याशालित्वमिच्छायाः पक्षधर्मता ।
इच्छाराशौ प्रतिव्यक्ति पूर्णरूपतया स्थितेः ॥ ५१४ ॥

प्रमाणसंख्याशालित्वं तावद्भागविकल्पनात् ।
इच्छाराशेः प्रतिव्यक्ति प्रमाणगुणने ततः ॥ ५१५ ॥

तत्फलेनाहृता सैव फलत्वेनानुमीयते ।
इच्छातत्फलयोः सिद्धिः प्रमाणोद्धरणात्ततः ॥ ५१६ ॥

व्याख्या—1. A. B. C. यप्तोप 2. A. गणिका (? गमिका)

प्रमाणफलयोः संख्यासम्बन्धे तादृशे सति ।
यावान् भागः प्रमाणस्य तावान् भागः फलस्य च ।। ५१७ ।।

पूर्णरूपेष्वियांशेषु तयोर्व्याप्तेरबाधनात् ।
इतीच्छायां प्रतिव्यक्ति फलतुल्ये फले कृते ।। ५१८ ।।

प्रमाणांशतया तस्य तेनाऽऽप्तं वास्तवं फलम् ।
इच्छायाः संख्ययाऽऽवृत्तं प्रमाणं यत्र कल्प्यते ।। ५१९ ।।

तयैव संख्ययाऽऽवृत्तं तत्फलं तत्र कल्पयेत् ।
तत्पुनः पूर्णरूपं वा यद्वा भागात्मकं भवेत् ।। ५२० ।।

पूर्णरूपतयाऽऽवृत्तेरिच्छाव्यक्तिष्वसम्भवात् ।
भागात्मकत्वेनाऽऽवृत्तिः प्रमाणस्य तु कल्प्यते ।। ५२१ ।।

ततः प्रमाणभागत्वं तत्फलानां च निश्चितम् ।
ततः प्रमाणसम्भक्तमिष्यते वास्तवं फलम् ।। ५२२ ।।

यावद्वा खण्डितो यस्तु खण्डैस्तावद्भिरेव सः ।
पूर्यते भागहारोऽतस्तावांस्तेषामुपाश्रितः ।। ५२३ ।।

यदावृत्तं यदंशं वा प्रमाणं यत्र दृश्यते ।
तदावृत्तं तदंशं वा तत्फलं तत्र कल्पयेत् ।। ५२४ ।।

इच्छायाः पूर्वसिद्धत्वाद्विशेषाभावतस्तथा ।
गुणनं हरणं चापि प्रमाणेन न कल्प्यते ।। ५२५ ।।

यत्र स्याद्यावती व्यक्तिस्तत्रैव व्यक्तिजं फलम् ।
तावत्कृतं विजानीयात् कृत्स्नव्यक्तिगतं फलम् ।। ५२६ ।।

तस्य प्रमाणभागत्वात् तेनावाप्तं फलं स्फुटम् ।
यदंशा यस्य ये भागास्तेभ्यस्तैस्तस्य[1] पूरणात् ।। ५२७ ।।

इच्छाहृतं फलं तस्मात् प्रमाणेन विभज्यते ।
यद्वेच्छायां[2] प्रमाणस्य यावन्तः स्युः फलांशकाः ।। ५२८ ।।

तावतीश्च फलव्यक्तीरिच्छाराशौ प्रकल्पयेत् ।
प्रमाणतः फलावाप्तमिच्छाराशेर्विशोधयेत् ।। ५२९ ।।

व्याख्या—1. B. तेभ्यस्ते तस्य 2. A. यद्वेच्छायाः

आवृत्या[1] शुद्धसंख्या च यदि वेच्छाफलं भवेत् ।
फलांशत्वात् प्रमाणस्य हार्यं तत्फलराशिना ।। ५३० ।।

तत्र लब्धफलेनेच्छां हरेदिष्टफलाप्तये ।
प्रमाणलब्धं वेच्छायाः फलेन गुणयेत् पुनः ।। ५३१ ।।

यतो भागेन हर्तव्ये हार्यं छेदेन गुण्यते ।
फलावृत्तं प्रमाणं चेत् भागहारतया स्थितम् ।। ५३२ ।।

इच्छा व्यावर्तनीयैव तदा वृद्धफलाप्तये ।
भागहारे ततो भाज्यो हारावृत्या निहन्यते ।। ५३३ ।।

इति केश्चित् फलघ्नेच्छा प्रमाणेन विभज्यते[2] ।
इच्छां प्रमाणभक्तां वा फलेन गुणयेत् पुनः ।। ५३४ ।।

यद्वा प्रमाणभागत्वं स्वफले यादृशं स्थितम् ।
तादृशानि फलान्येवमिच्छाव्यक्तिषु कल्पयेत् ।। ५३५ ।।

प्रमाणेन फलाल्लब्धं यत् तेनेच्छा निहन्यते ।
तत्र यद्वा फलघ्नेच्छा प्रमाणेन विभज्यते ।। ५३६ ।।

भागेन गुणने गुण्यश्छेदेन[3] ह्रियते यतः ।
फलं प्रमाणावृत्तं चेद् गुणकारतया मतम् ।। ५३७ ।।

तद्वृत्त एव गुण्यस्तु कार्यो वृद्धफलाप्तये ।
अत एवांशगुणने गुणच्छेदोऽपि हारकः ।। ५३८ ।।
गुणगुण्यत्वोपपत्तिस्तथेच्छाफलयोर्मिथः ।। ५३९ ।।

[भगणानयने त्रैराशिकयोजना]

भूविन्नविलग्ने दृष्टे प्रमाणे भगणादिभिः[4] ।
तुल्यं तत्फलमंशानां तादृक्सम्बन्धबोधकम् ।
अंशाद्ये[5] स्वनियमात् सर्वेषां सर्वांशिनाम् ।। ५४० ।।

व्याख्या—1. A. आवृत्यं
2. C. Hapl. om. after विभज्यते to विभज्यते in verse 536.
3. A. C. गुण्ये छेदेन 4. B. प्रमाणभगणादिभिः
5. B. C. अंशाद्ये

संख्यासम्बन्धनियमस्तथाभूतस्तयोर्न चेत् ।
कथं तथैव दृश्येते मुहुर्भगणभूदिने ॥ ५४१ ॥

संख्यासम्बन्धनियमः प्रमाणस्य फलस्य च ।
सर्वेषां च तदंशानां शक्यः कल्पयितुं ततः ॥ ५४२ ॥

नन्वेकस्मिन् युगे दृष्टे सकृद् भगणभूदिने ।
भूयोदर्शननिर्णेया मिथो व्याप्तिः[1] कथं तयोः ॥ ५४३ ॥

अत्रोच्यतेंऽशिनां यस्मादंशारब्धत्वमिष्यते ।
अंशानां नियमाभावे नियमः कथमंशिनोः ॥ ५४४ ॥

अंशिनोर्नियमाभावे चांशानां नियमः कथम् ।
अंशांशिनोः फलव्याप्तिस्तुल्यरूपा भवेत्ततः ॥ ५४५ ॥

सकृद्दर्शनतस्तस्मादंशिनोर्व्याप्तिनिर्णयात् ।
सर्वेषां च तदंशानां व्याप्तिर्निर्णीयते मिथः ॥ ५४६ ॥

ततोंऽशेषु फलव्याप्तिं तदंशिष्वपि कल्पयेत् ।
यथांशिनि फलव्याप्तिस्तदंशेष्वपि[2] कल्प्यते ॥ ५४७ ॥

अंशव्याप्तिश्च सुगमा गोलविद्भिः परीक्षकैः ।
ग्रहणग्रहयोगादेर्भूयोदर्शनशालिभिः ॥ ५४८ ॥

अतो भगणनिघ्नेषु द्युगणाद् युगभूदिनैः ।
कार्यस्त्रैराशिकेनैव मध्यमो भगणादिकः ॥ ५४९ ॥

छेदतुल्या भवन्त्यंशाः पूर्णे सर्वत्र चांशिनि ।
अंशानां छेदतुल्यानां योगेनांशित्वकल्पनात् ॥ ५५० ॥

भगणेंऽशिनि विद्यन्ते ततो द्वादश राशयः ।
भगणद्वादशांशत्वं राशीनां कल्पितं यतः ॥ ५५१ ॥

छेदतुल्यांशसङ्ख्याता छेदेषु भगणादिवत् ।
छेदघ्नशेषादाद्येन हारेणाप्तास्तदंशकाः ॥ ५५२ ॥

आद्यहारोद्धृतः शिष्टस्तच्छेदः सम्मतस्ततः ।
राशेस्त्रिंशांशका भागास्तत्षष्ट्यंशाः[3] कला मताः ॥ ५५३ ॥

व्याख्या—1. A. व्यक्तिः 2. A. स्तदांशेष्वपि
3. A. षष्ट्यंशः

तत्षष्ट्यंशाश्च विकलाः षष्ट्यंशास्तत्परास्ततः ।
ततः प्रतत्पराद्याश्च तत्तच्छेदघ्नशेषतः ॥ ५५४ ॥

[राश्यादिमध्यमे त्रैराशिकयोजना]

द्युदिनेनैव हारेण लभ्या राश्यादयोऽखिलाः ।
एवं त्रैराशिकेनैव मध्यमाप्तिर्द्युचारिणाम् ॥ ५५५ ॥

इति ।

इच्छाराशेः प्रमाणांशैस्तत्फलैः स्वफलोन्नयः ।
स्वफलव्याप्तयोः कार्यो द्वयोरिच्छाप्रमाणयोः ॥ ५५६ ॥

प्रमाणं स्याज्ज्ञातफलमिच्छा ज्ञेयफलाश्रयः ।
यावृङ्नियमतस्तत्र प्रमाणैः[1] स्वफलस्थितिः ॥ ५५७ ॥

इच्छाराशेः फलं तावृङ्नियमात् पृथगुद्धरेत् ।
अत एव फलघ्नेच्छा प्रमाणेन विभज्यते ॥ ५५८ ॥

पक्षीकृतायामिच्छायां प्रमाणांशफलोन्नये ।
यो यवंशः स तद्भक्तः पूर्णतामुपगच्छति ॥ ५५९ ॥

इच्छाफलं प्रमाणेन तत्फलं चेच्छया हतम् ।
तुल्यमेव भवेद् येन प्रमाणेच्छाफलाहतेः ॥ ५६० ॥

प्रमाणफलमिच्छाप्तं प्रमाणाप्तं तथेतरत् ।
गुणगुण्याहतेर्भाज्याद् यतो गुण्यो गुणोद्धृतः ॥ ५६१ ॥
गुण्योद्धृतो गुणोऽपि स्यात् तद्वद् भाज्याद् हरोद्धृतम् ।
इच्छाफलं भवेत्तस्मात् तत्फलाप्तश्च हारकः ॥ ५६२ ॥

इच्छाफलात् प्रमाणघ्नादिच्छाराशिः फलोद्धृतः ।
निश्शेषेऽथ सशेषे तु क्षेपशुद्धियुतोनितात् ॥ ५६३ ॥

यत्र गुण्यो गुणावृत्तो भाज्यत्वेन विवक्षितः ।
हारस्य तु ततस्त्यक्तस्याऽवृत्तिः फलमिष्यते ॥ ५६४ ॥

तत्र गुण्यो गुणावृत्तः फलावृत्तश्च हारकः ।
[तुल्यौ] [2]स्यातां ततो भाज्याद् हारेण स्वफलं यथा ॥ ५६५ ॥

व्याख्या—1. A. C. प्रमाणे
2. A. तुल्या; B. C. तुल्यो

तथा गुणेन गुण्योऽपि गुण्येनापि गुणो भवेत् ।
हारभक्तः सशेषश्चेद् भाज्यस्तत्फलहारयोः ॥ ५६६ ॥

संवर्गाच्छेषसंयुक्ताद् भवेद् गुण्यो गुणोद्धृतः ।
शेषोनादूनशेषश्चेद् गुण्यो गुण्योद्धृतोऽथवा ॥ ५६७ ॥

फलावयवक्लृप्तिस्तु शेषतः क्रियते यतः ।
सर्वत्रावयवच्छेदगुणितात् पूर्वहारतः ॥ ५६८ ॥

फलहारकसंवर्गात् सशेषात् तद्गुणोद्धृतः ।
गुण्यो भवेद् ययोर्घातः पूर्वं भाज्यः प्रकल्पितः ॥ ५६९ ॥

यस्याद्येनोद्धृतं यत् स्यात् तत् तेनैव हतं पुनः ।
हृतशेषयुतं भाज्यराशिः पूर्वोदितो भवेत् ॥ ५७० ॥

स्वपूर्वशेषात् स्वच्छेदहताद् भाज्याद् हरोद्धृताः ।
राश्यादयो भवेयुस्ते भगणावयवास्ततः ॥ ५७१ ॥

कलाविशेषा हारघ्नतत्कलासु समन्विताः ।
कलाविच्छेदनिहताः पूर्वशेषा भवन्त्यतः ॥ ५७२ ॥

गुण्यो गुणो हतो भाज्यः शेषस्तत्र हरोद्धृते ।
शेषहीनस्ततो भाज्यो निश्शेषो हारकोद्धृतः ॥ ५७३ ॥

छेदो येन हतः शेषयुक्तोनो हारकोद्धृतः ।
निश्शेषः स गुणः पूर्वशेषो राश्यादिकं फलम् ॥ ५७४ ॥

छेदभाज्येऽत्र राश्यादेः पूर्वशेषो गुणो भवेत् ।
पूर्वशेषस्य भाज्यत्वे छेदोऽसौ कल्प्यते गुणः ॥ ५७५ ॥

द्वयोरपि तयोर्घातान्निजशेषयुतोनितात् ।
राश्यादिर्जायते यस्मान्निश्शेषं हारकोद्धृतः ॥ ५७६ ॥

इति ।

तथा—

[कुट्टाकारे त्रैराशिकयोजना]

अतःपरं प्रमाणस्य फलं भाज्य इतीर्यते ।
भाज्ये हारेण विहृते हाराप्तिर्विमिणोच्यते ॥ ५७७ ॥

आवृत्तिगुणितो हारो भाज्यः शेषयुतो यतः ।
हाराच्च भाज्यशेषेण तदावृत्तिर्विशोध्यते ॥ ५७८ ॥

स्वावृत्तिघ्नस्ततः शेषतच्छेषावधः स हारकः ।
यस्माल्लब्ध्या यदावृत्तिस्तयोर्घातः स जायते ॥ ५७९ ॥

निश्शेषेऽथ सशेषे तु घातस्तच्छेषसंयुतः ।
हारस्वफलघातो यः स भाज्यो भाज्यशेषयुक् ॥ ५८० ॥

भाज्यशेषस्वफलयोर्घातो हारः स्वशेषयुक् ।
भाज्यभाजकयोर्न्यायो योज्यस्तच्छेषहारयोः ॥ ५८१ ॥

हारशेषफलाभ्यासो भाज्यशेषः स्वशेषयुक् ।
भाज्यशेषो यतो हारशेषावृत्त्या सशेषया ॥ ५८ ॥

भाज्यस्वशेषतच्छेषा स्वतत्तच्छेषसंयुतैः ।
हारस्वशेषतच्छेषैः स्वतस्तत्फलसंहृतैः ॥ ५८३ ॥

भाज्यस्य शेषतच्छेषैस्तथा स्वस्वफलाहृतैः ।
हारस्वशेषतच्छेषाः स्युस्तत्तच्छेषसंयुतैः ॥ ५८४ ॥

भाज्यभाजकशेषाणां फलानि क्रमशो न्यसेत् ।
[1]वल्लीरूपे परिवधस्तौ शेषौ हारभाज्ययोः ॥ ५८५ ॥

हारशेषविभक्ते तु भाज्यशेषे यदाल्पता ।
तावत्कुर्यादिदं भाज्यशेषे कल्प्या मतिस्ततः ॥ ५८६ ॥

स्वल्पावाप्तफलाभ्यस्तः सशेषः स्वल्पको महान् ।
स्वल्पशेषोद्धृतफलाभ्यस्तशेषः स्वशेषयुक् ॥ ५८७ ॥

स्वल्पतत्फलयोर्घातो यतः शेषान्वितो महान् ।
शेषतत्फलयोर्घातः स स्वशेषान्वितोऽल्पकः ॥ ५८८ ॥

तस्माद् येन हृतं लब्धं तत् तेनैव हृतं पुनः ।
हृतशेषेण संयुक्तं भाज्यराशिर्भवेद् यतः ॥ ५८९ ॥

हारशेषस्वफलयोः संवर्गो भाज्यशेषयुक् ।
भाज्यस्य पूर्वशेषः स्याद् हारशेषेण यो हृतः ॥ ५९० ॥

व्याख्या—1.　A. B. वल्लीरूपेण रिवधस्तौ (A. rev. to वल्लीरूपे परिवधस्तौ);
C. °निवधस्तौ

हारतत्फलयोर्घातो निजशेषयुतस्ततः ।
स्वपूर्वपूर्वशेषं स्याद्यथान्ते भाज्यभाजकौ ॥ ५९१ ॥

अयुग्मफलशेषाभ्यामाद्यो भाज्यः सशेषकः ।
लभ्यते भाजकोऽप्यन्यो युग्मशेषफलैरिह ॥ ५९२ ॥

अन्त्ययोः शेषयोः स्वल्पो भाज्यशेषोऽधिकोऽपरः ।
स्वल्पशेषयुतोऽनल्पशेषान्त्यफलयोर्वधः ॥ ५९३ ॥

पूर्वशेषो भवेदेवमुपान्त्यानल्पयोर्वधः ।
तत्रत्यस्वल्पशेषेण योज्यश्चैव मुहुर्मुहुः ॥ ५९४ ॥

तावत्कुर्यादिदं कर्म यावद्राशिद्वयं भवेत् ।
अन्त्यो राशिर्भवेद् भाज्यस्तत्रोपान्त्यश्च भाजकः ॥ ४९५ ॥

भाज्यश्चेदुपरिन्यस्तो भाज्यशेषस्तवोपरि ।
अधश्चेद् भाज्यशेषोऽधो हारशेषस्ततोऽपरः ॥ ५९६ ॥

तयोरेकतरेणान्यो निश्शेषं चेद् विभज्यते ।
तेन हारेण कृत्स्नौ तौ हर्तव्यौ भाज्यभाजकौ ॥ ५९७ ॥

यतस्तेन हृताः पूर्वशेषा वल्ली च यत्फलम् ।
अन्योन्यहृतशेषेण हृतयोर्भाज्यहारयोः ॥ ५९८ ॥

निश्शेषतां ततः प्राहुर्दृढतामपि सूरयः ।
निश्शेषहरणाभावादन्येन दृढता तयोः ॥ ५९९ ॥

राश्योरन्योन्यहरणे मुहुर्योऽन्तेऽवशिष्यते ।
तावुभावपि हर्तव्यौ निश्शेषं तेन राशिना ॥ ६०० ॥

यतस्तेनैव शिष्टेन निश्शेषं विहृतोऽपरः ।
तदन्यशेषस्तेनापि पूर्वं निश्शेषतो हृतः ॥ ६०१ ॥

एवं सर्वेऽपि शेषास्ते स्वान्यशेषस्य[1] हारकाः ।
राश्योर्द्वयोः स्वामावृत्तिं कल्पयन्त्यविबाधतः ॥ ६०२ ॥

मिथो विभक्तशेषस्य स्यादावृत्तिर्द्वयोस्ततः ।
दृढतां तत एवाहुस्तयोः [2]शिष्टविभक्तयोः ॥ ६०३ ॥

व्याख्या—1. C_2 स्वावशेषस्य 2. B. शेष for शिष्ट

अनल्पराशिशेषेण स्वल्पो यदि विभज्यते ।
स्वल्पावृत्त्या हृतोऽनल्पभागस्तेन हृतो भवेत् ॥ ६०४ ॥

ऊर्ध्वशेषेण सर्वत्र न्यायोऽयं मुहुरूह्यताम् ।
अन्त्यशेषेण शेषाणां तयो राश्योर्द्वयोरपि ॥ ६०५ ॥

निश्शेषं ह्रियमाणत्वे न काप्यनुपपन्नता ।
अन्त्यशेषसमारब्धौ सशेषौ तावुभौ यतः ॥ ६०६ ॥

अन्योन्यभक्तशेषेण भाज्यभाजकयोस्ततः ।
निश्शेषं ह्रियमाणत्वाद् दृढतैवोपपद्यते ॥ ६०७ ॥

तत्राल्पो भाजकाद्भाज्यस्तेन न ह्रियते यदा ।
तदा कयाचिन्मत्यासौ गुणितो ह्रियते पुनः ॥ ६०८ ॥

यत्र भाजकसंभक्तशेष उद्दिश्यते बुधैः ।
यतो भाज्ये प्रतिव्यक्ति मतिरावर्त्यते गुणे ॥ ६०९ ॥

ततो व्यक्तिषु सर्वासु हृतशेषोऽपि भिद्यते[1] ।
हारतत्फलयोर्घाते हरणेन पृथक् कृते ॥ ६१० ॥

भाज्यतः शिष्टमुद्दिष्टं ततस्तेन विवर्जितात् ।
निश्शेषहरणं भाज्याद् भाजकेनोपपद्यते ॥ ६११ ॥

हारतत्फलयोर्घाताद् यद्वा तच्छेषसंयुतात् ।
निश्शेषहरणं मत्या कार्यं भाज्येन वा ततः ॥ ६१२ ॥

हारतत्फलयोर्घातो योऽप्यन्यो मतिभाज्ययोः ।
उद्दिष्टशेषमनयोरन्तरं प्रतिजानते ॥ ६१३ ॥

उद्दिष्टशेषरहितः संवर्गो मतिभाज्ययोः ।
हारेण ह्रियते स्वल्पे हारतत्फलयोर्वधे ॥ ६१४ ॥

मत्या भाज्येन वा हार्यः स वा शेषेण[2] संयुतः ।
हारतत्फलयोर्घातो महांश्चेत् तद्विपर्ययात् ॥ ६१५ ॥

व्याख्या—1. B. शेषो विभिद्यते 2. A. C. सावशेषेण

यद्वावृत्तस्ततो भाज्यः क्षेपशुद्धियुतोनितः ।
यद्वावृत्तेन हारेण तुल्यः स्यादिति चिन्त्यते ॥ ६१६ ॥

आवृत्तिद्वितयं भाज्यहारयोर्मतितत्फले ॥ ६१७a ॥

[भगणाद्यानयने कुट्टकयोजना]

भगणादौ वृढे भाज्ये भाजके वृढवासरे ॥ ६१७b ॥

इष्टाहर्गणतुल्यः स्याद् गुणः स्वमतिकल्पितः ।
उद्दिष्टशेषस्तत्रैव भवेन्नान्यत्र कुत्रचित् ॥ ६१८ ॥

हारावृत्तिस्ततो लब्धाः ग्रहाणां भगणा मताः ।
यतो भगणशेषत्वं तत्र शिष्टस्य कल्प्यते ॥ ६१९ ॥

राशीनां द्वादशांशानां च्छेदे भाज्ये कृते ततः ।
दृढवासर एवैकः पूर्वोक्तो भाजको मतः ॥ ६२० ॥

मतिर्भगणशेषः स्यात् तत्फलं राशयो गताः ।
भवेदुद्दिष्टशेषोऽपि राशिशेषस्तदा स्फुटम् ॥ ६२१ ॥

यतो तत्रैव शिष्टत्वं तस्य भाज्ये हरोद्धृते ।
भागच्छेदसमे भाज्ये पूर्वोक्ते भाजके ततः ॥ ६२२ ॥

राशिशेषो मतिः कल्प्या गतभागाश्च तत्फलम् ।
भागशेषस्तदुद्दिष्टस्तत्रैव स्यान्न चान्यतः ॥ ६२३ ॥

लिप्ताच्छेदे तथा भाज्ये भाजके वृढवासरे ।
भागशेषो मतिस्तत्र ग्रहभुक्तकलाः फलम् ॥ ६२४ ॥

उद्दिष्टो [1]लिप्तिकाशेषस्तत्रैव तु भवेत् स्फुटम् ।
भाज्ये च विकलाच्छेदे पूर्वोक्ते भाजके सति ॥ ६२५ ॥

कलाशेषो मतिर्भुक्ता ग्रहेण विकला फलम् ।
उद्दिष्टो विकलाशेषो यतस्तत्रैव सम्भवेत् ॥ ६२६ ॥

भाज्ये तु भगणादीनां शेषे प्रोक्ते च हारके ।
राश्याद्विशेषे चोद्दिष्टे तत्तच्छेदो मतिर्गुणः ॥ ६२७ ॥

ग्रहभुक्ताश्च राश्याद्याः फलं तत्रापि पूर्ववत् ।
राश्याद्विशेषाश्चोद्दिष्टाः प्रागुक्ता एव कल्पिताः ॥ ६२८ ॥

व्याख्या—1. A, B. लिप्तका

मिथो विभक्तयोर्यद्वा भाज्यभाजकयोर्द्वयोः ।
भाज्यशेषेऽल्पके कल्प्या मतिर्भाजकशेषतः ।। ६२९ ।।

ज्ञेयं तत् प्रथमं भक्ते भाजके भाज्यराशिना ।
मिथो विभज्य लब्धानां फलानां युग्मतावशात् ।। ६३० ।।

वल्लीफलानामोजत्वं पूर्वं भाज्ये हरोद्धृते ।
भाजकाद्धिके भाज्ये भाजकेन ततो हृतम् ।। ६३१ ।।

वल्लीफलानां युग्मत्वापेक्षया कल्प्यते पृथक् ।
तस्माद् भाज्येऽधिके पूर्वं भाजकेनोद्धृते सति ।। ६३२ ।।

वल्लीफलान्ययुग्मानि युग्मान्येव ततोऽन्यथा ।
भाजकाद्यथा भाज्यात्तदन्याप्तं तु यत्फलम् ।। ६३३ ।।

तच्छेषाप्तं तथाऽन्यस्माद् वल्ल्यां स्थाप्यं फलद्वयम् ।
एवं मुहुर्मुहुः कार्यं फलद्वन्द्वाऽनतिक्रमात् ।। ६३४ ।।

फलद्वन्द्वसमारब्धा तद्वल्ली च ततो भवेत् ।
मतिर्मतिफलस्याधो वल्ल्यास्तस्याः क्रमान्न्यसेत् ।। ६३५ ।।

तेषूपान्त्यतद्वासन्नफलाभ्यासोऽन्त्यसंयुतः ।
कार्यो मुहुरुपान्त्यान्त्योपान्त्याभ्यासेऽन्त्यसंयुतिः ।। ६३६ ।।

तावदेव विधिः कार्यो यावत् पङ्क्तिद्वयं भवेत् ।
तृतीयराश्यभावेन तावदेतन्निवर्तते ।। ६३७ ।।

भाज्येन भाजकाल्लब्धे न्यस्ते प्रथमतः फले ।
वृद्धवासरभक्तावशेषितो द्युगणो भवेत् ।। ६३८ ।।

भाजकावृत्तिरूपाणां मण्डलानां विशोधनात् ।
[1]द्वितीये भाज्यतो लब्धे भाजकेन फले सति ।। ६३९ ।।

वृद्धभाज्येन भक्तावशिष्टाः स्युर्भगणा गताः ।
तद्भाज्यावृत्तिरूपाणां मण्डलानां विशोधनात् ।। ६४० ।।

यदा तु भाज्यतो लब्धं भाजकेनोपरि स्थितम् ।
तस्मिन् भाज्येन विहृते शिष्टाः स्युर्भगणास्तदा ।। ६४१ ।।

व्याख्या—1. A. C. omit the next three lines haplographically.

वल्लीफलान्युपान्त्योर्ध्वघातान्त्यफलयोगतः ।
यदा [1]वल्ल्युपसंहारे भवेतां भाज्यभाजकौ ॥ ६४२ ॥

यावृङ्नियमतो यत्र शेषौ भाजकभाज्ययोः ।
तावृङ्नियमतस्तत्र कल्प्येते मतितत्फले ॥ ६४३ ॥

भाज्यहारौ स्वतोऽन्याप्तहृतेऽन्यस्मिन् सशेषके ।
अखण्डावेव तौ स्यातामन्यत्र तु तनूकृतौ ॥ ६४४ ॥

[एवं तु][2] वृढभाज्याभ्यां ततो भक्तावशेषितौ ।
अभीष्टद्युगणातीतभगणौ भवतः स्फुटम् ॥ ६४५ ॥

भाज्यहारौ वृढौ भागरूपौ यन्महृतस्तयोः ।
द्युगणो मतिरन्यत्र तत्फलं भगणादयः ॥ ६४६ ॥

महता हारशेषेण भाज्यशेषस्ततोऽल्पकः ।
क्षेपशुद्धियुतोनोऽपि न निश्शेषं विभज्यते ॥ ६४७ ॥

अतः केनापि गुणितो हर्तव्यो हारकेण सः ।
स एव गुणकारोऽत्र मतित्वेन प्रकल्प्यते ॥ ६४८ ॥

यतो नान्येन केनापि गुणितो ह्रियते ततः[3] ।
यस्य कस्यचिदेकस्य सम्भवात् पर्यये क्वचित् ॥ ६४९ ॥

भाज्यराशिरयं केन गुणितः शेषवर्जितः ।
हृतो हारेण निश्शेषो गुणो मत्येति कल्प्यते ॥ ६५० ॥

स तु[4] निश्शेषहरणपारतन्त्र्यान्नियम्यते ।
उद्दिष्टशेषा विविधा गुणान्तरपरिग्रहे ॥ ६५१ ॥

शेषभाजकयोर्योगात् तत्र भाज्योवृधृता मतिः ।
तद्गुणो ह्रियते भाज्यः शेषोनो भाजकेन यत् ॥ ६५२ ॥

व्याख्या—1. B. C. सदा

2. A. B. C. Three syllables are missing ; B. indicates the omission by dots.

3. B. C. तथा 4. B. स्तुति

यदा पुनः सशेषत्वाद्योगो न ह्रियतेऽनयोः ।
तदा भाज्यहृतोद्दिष्टशेषशेषो न भाज्यतः ॥ ६५३ ॥

भाज्यभाजकयोर्भेदविभक्ताद् भाजकाहृतात् ।
ततो भाज्येन यल्लब्धं तदेव मतिरिष्यते ॥ ६५४ ॥

यस्मादुद्दिष्टशेषोनाद् भाज्याद् यदवशिष्यते ।
शेषाद् भाज्यविभक्तावशिष्टोनाद् वाथ भाज्यतः ॥ ६५५ ॥

भाज्यभाजकयोर्भेदाऽवृत्त्या तत्तु प्रपूर्यते ।
शेषाद् भाज्यविभक्तोंऽशो यश्चान्यो भाजकादपि ॥ ६५६ ॥

तयोर्भाज्येन निश्शेषहरणं नातिदुष्करम् ।
उद्दिष्टशेषाद् भाज्येन भक्ता शिष्टोनभाज्यतः ॥ ६५७ ॥

एकरूपः सदा शेषो यदावृत्ते तु भाजके ।
पूर्णस्तद्भाज्यभेदेन भाजकात् तेन ताडितात् ॥ ६५८ ॥

उद्दिष्टशेषसंयुक्तात् भाज्येनाप्ता मतिर्भवेत् ।
यतस्तद्गुणितो भाज्यो हारेण ह्रियतेऽखिलम् ॥ ६५९ ॥

गन्तव्यशेषे तूद्दिष्टे भाज्ये क्षेप्यो भवेदसौ ।
क्षेपयुक्तस्तदा भाज्यो भाजकेन विभज्यते ॥ ६६० ॥

यस्यैव हरणाभावे हृतः केनापि पूर्ववत् ।
स एव गुणकारः प्राङ् मतित्वेन निरूपितः ॥ ६६१ ॥

उद्दिष्टशेषरहिताद् भाजकादवशिष्टतः ।
भाज्यभाजकयोरन्तरोद्धृता स्यात् तदा मतिः ॥ ६६२ ॥

यया संगुणितो भाज्यशेषः शेषेण संयुतः ।
हारशेषेण निश्शेषं विभज्येत निरर्गलम् ॥ ६६३ ॥

मिथो हरणतो भाज्यशेषेऽल्पे कल्प्यतां मतिः ।
निश्शेषहरणेऽन्यत्र तेनापि गुणितादपि ॥ ६६४ ॥

आस्तां वा क्षेपगुद्धयन्वितोनितात् भाज्यशेषतः ।
हारशेषेण निश्शेषं हरणे मतिकल्पनम् ॥ ६६५ ॥

अन्योन्यहरणाद् भाज्यशेषरूपं यदा भवेत् ।
कल्प्यतां तत्र तूद्दिष्टशुद्धिशेषसमा मतिः ॥ ६६६ ॥

भवेद् भाजकशेषेऽपि रूपसंख्ये मतिः क्वचित् ।
क्षेपशुद्ध्योर्विपर्यासाद् यत्र वल्ल्युपसंहृतिः ॥ ६६७ ॥

उद्दिष्टशेषः क्षेपोऽपि शुद्धिरेवात्र कल्प्यते ।
क्षेपशुद्ध्योर्विपर्यासाद् भाज्यभाजकयोर्मिथः ॥ ६६८ ॥

तथा हि भाजकावृत्तिरुद्दिष्टक्षेपसंयुता ।
भाज्यशेषेण हर्तव्या तद्वद्भाज्यः फलाहतः ॥ ६६९ ॥

उद्दिष्टशेषरहितो भाजकेन विभज्यते ।
अथवा भाजकावृत्तिरुद्दिष्टक्षेपवर्जिता ॥ ६७० ॥

ह्रियते भाज्यशेषेण तद्वद्भाज्यः फलाहतः ।
उद्दिष्टशेषसहितो भाजकेन विभज्यते ॥ ६७१ ॥

भाज्यभाजकयोस्तस्मात् क्षेपशुद्ध्योर्विपर्ययः ।
तयोरन्तरमावृत्त्योः शेष एको भवेद् यतः ॥ ६७२ ॥

भाज्यशेषे[1] भवन् क्षेपो भाजके शुद्धितामियात् ।
भाजके च भवन् क्षेपो भाज्ये शुद्धित्वमाप्नुयात् ॥ ६७३ ॥

शुद्धिक्षेपौ विपर्यस्तौ भाज्यभाजकयोस्ततः ।
रूपसंख्ये तयोर्भाज्ये कल्प्या शुद्धिसमा मतिः ॥ ६७४ ॥

यतो मतिहताद् भाज्यात् सैव शुद्धिर्विशोध्यते ।
भाज्यक्षेपो[2] भवेद्यस्तु शुद्धिः सा भाजके भवेत् ॥ ६७५ ॥

यतो मतिहताद् भाज्यात् सैव शुद्धिर्विशोध्यते ।
शेषाभावात्तु हारेण हरणाभावतस्तदा ॥ ६७६ ॥

शून्यं मतिफलं ताभ्यां वल्ल्या चानीतयोक्तवत् ।
कृते वल्ल्युपसंहारे स्यातां तौ भाज्यभाजकौ ॥ ६७७ ॥

भाज्ये रूपे मतिर्योगो भाजकोद्दिष्टशेषयोः ।
अतो मतिफलस्यात्र रूपत्वाद् भाज्यतुल्यता ॥ ६७८ ॥

उद्दिष्टशेषतुल्या चेन्मतिरत्र प्रकल्प्यते ।
शून्यं मतिफलं ज्ञेयं यदा[3] शेषस्य शून्यता ॥ ६७९ ॥

व्याख्या—1. A. शेष for शेषे 2. A. भाज्ये क्षेपो 3. A. तदा for यदा

भाज्यतुल्यं मतिफलं भाजकेन समा मतिः ।
भाज्यभाजकशेषाभ्यां द्वाभ्यां वल्ल्युपसंहृतौ ॥ ६८० ॥

उपर्यधोगतौ स्यातामखण्डौ भाज्यभाजकौ ।
तस्याबाधूलिरेकैव हीयते हारभाज्ययोः ॥ ६८१ ॥

कृते वल्ल्युपसंहारे प्रागुक्तमतिकल्पनात् ।
भाज्ये प्रागुपरि न्यस्ते तत्पङ्क्ति तेन संहरेत् ॥ ६८२ ॥

आधस्थ्यपङ्क्ति हारेण न्यस्ते व्यत्ययतोऽन्यथा ॥ ६८३ ॥

इति ।

[सूर्यस्य वृढभगणभूदिनैः कुट्टकक्रिया]

सर्वत्रेष्टगुणाऽसाध्ये सिद्धयोः स्वर्णरूपयोः ।
क्षेत्रयो[1]रन्तराबाधाविष्टक्षेपः प्रसाध्यते ॥ ६८४ ॥

तद्गुणोऽपि ततः साध्यः सिद्धक्षेपगुणान्वयात् ।
बोद्धव्यमेतदेवात्र तत्त्वं कुट्टककर्मणि[2] ॥ ६८५ ॥

संख्यामुद्दिश्य तद्वक्ष्ये वर्णैः कटपयादिभिः ।
576 210389
तथा हि 'तत्समे' भाज्ये 'धीजगन्नूपुरे' हरे ॥ ६८६ ॥

149 129
तदन्योन्यहृतौ शेषाः [क्रमाद्][3] 'धीबन्धु'-'धीप्रियौ'[4] ।
20 9 2 1
'नरो' 'धी' 'श्रीः' 'किम्' इत्येषां क्षेपाद्ये तद्गुणाः क्रमात् ॥ ६८७ ॥

365 1096 1461 9862
'मार्तण्ड'-'स्तब्धनयनः' 'कार्तवीर्यो' 'व्रताविधीः' ।
21185 94593[5]
'महाकायप्रनुरू'-'लब्धशुभाधीनः' फलानि तु ॥ ६८८ ॥

1 3 4 27 58 259
कि-गौ-वित्-सार-हेमानो-धर्मराड् इत्यमूनि षट् ।
365 3 1 6 2 4
क्रमाद्वल्लीफलान्यत्र 'मार्तण्डा' 'ल' 'ङ्कु' 'तौ' 'र' 'विः' ॥ ६८९ ॥

व्याख्या—1. B. क्षे(प)योः, with प within brackets.

2. A. B. कटुककर्मणि 3. A. B. C. क्रमा 4. A. धीर्ययौ

5. The correct figure, however, is 94602. The wrong figure is repeated also below, in verses 715 (p. 66), and 726 (p. 67).

एष्वेव योज्य उदिततत्त्वन्यायश्च तद्यथा ।

576 210389

'तत्समे'-नाद्यहरणे 'धीजगन्नूपुरात्' फलम् ॥ ६९० ॥

365 149

'मार्ताण्ड:' शिष्यते योऽत्र धनक्षेप: स 'धावक:' ।

365 576

यतो 'मार्ताण्ड'-निहत-'तत्समे' न्यूनताऽमुना ॥ ६९१ ॥

हारशेषो धनात्माऽतो भाज्यशेषस्त्वृणात्मक: ।

365 149

अथ त्रिगुण-'मार्ताण्डे' न्यूनांशस्त्रिघ्न-'धावक:' ॥ ६९२ ॥

576

त्रिघ्नं प्रत्यधिकांश: स्यात् 'तत्समो'-ऽतोऽनयोर्भिदा ।

129 1096

'धीप्रियो'-ऽस्मिन् ऋणक्षेपे सति 'स्तब्धनयो' गुण: ॥ ६९३ ॥

149 576

यतोऽसौ त्रिघ्न-'धीवन्द्य'-'तत्समा'-नां विनान्वय: ।

149 129 20

अथ 'धीवन्द्य'-'धीप्राय'-शेषं[1] द्वयभिदा 'नर:' ॥ ६९४ ॥

365 1096

'मार्ताण्ड'-'स्तब्धनयन'-द्वययोगो गुणोऽस्य तु ।

20 1461

धनक्षेपे सति 'नरे' 'कार्तवीर्यो' गुणस्तत: ॥ ६९५ ॥

20 129 9

अथ षड्घ्ने 'नरे' त्यक्ते 'धीप्रिया'त् शिष्यतेऽत्र 'धी:' ।

1096 1461

'स्तब्धनित्या'-न्वित: षड्घ्न-'कार्तवीर्यो' गुणो यदा ॥ ६९६ ॥

9 9862

तदा 'धी:' स्याद् ऋणक्षेपो गुणस्तु 'प्रीतिवं धनम्' ।

न्यायोऽयमूह्यतामन्त्यगुणयोरुभयोस्तथा ॥ ६९७ ॥

गुणोक्तन्यायतश्चैवो फलानि स्यु: समन्वयात् ।

इष्टक्षेप[2]गुणाश्चैतैरेव शेषैर्नयेद् यथा ॥ ६९८ ॥

व्याख्या —1. The mss. read शेष for शेषं   2. A. क्षेपे

धनक्षेपः शतं, कोऽस्य गुणः, प्रश्नो यदीदृशः ।

149

'धीवन्द्या'-घ्नैर्धनक्षेपं शतसंख्यं नयेत् तदा ॥ ६९९ ॥

149　129　5

'धीवन्द्य'-'धीप्रियौ' 'मा'घ्नौ यौ तयोरन्तरं शतम् ।

क्षेपस्तद्गुणयोगो यः पञ्चघ्नः स गुणोऽस्य तु ॥ ७०० ॥

14　20　20　9　100

'विद्या'घ्न-'नर'-'नारी'घ्न-'धी'-[द्वयान्तरम् 'उन्नयः'][1] ।

क्षेपो गुणो वा तन्निघ्नतद्गुणद्वयसंयुतिः ॥ ७०१ ॥

210389　7305

'धीजगन्नूपुरो'नं वा तदा 'मौनी लसन्' भवेत् ।

ततोऽपि भाज्यहरयोरल्पत्वापादने कृते ॥ ७०२ ॥

गुणसिद्धिरनायासादतस्तद्विधिरुच्यते ।

महतोर्भाज्यहरयोरिष्टक्षेपोचितो गुणः ॥ ७०३ ॥

अशक्यावगमो यस्मात् तस्मादन्योन्यभाजनात् ।

कृत्वाल्पतां तयोः साध्ये गुणलब्धी च तद्यथा ॥ ७०४ ॥

अन्योन्यहरणं तावद् दृढयोर्भाज्यहारयोः ।

यावदेकत्र रूपं स्यात् क्रमान्न्यस्येत् फलान्यधः ॥ ७०५ ॥

क्षेपं शून्यं च तदधो वल्लीं तां चोपसंहरेत् ।

तत्र हारे यदा रूपं धनक्षेपस्तदोचितः ॥ ७०६ ॥

मतिस्थानीयगुणकः शून्यं क्षेपस्तदा फलम् ।

यदा भाज्ये भवेद् रूपमृणक्षेपस्तदोचितः ॥ ७०७ ॥

मतिस्थानीयगुणकः क्षेपः शून्यं तु तत्फलम् ।

न्यस्येदिहोभयत्रापि क्षेपं शून्यं च वल्ल्यधः ॥ ७०८ ॥

अधोपसंहृतिन्यायात् क्षेपघ्नान्त्यफले क्षिपेत् ।

शून्यं तदान्त्यहरणात् प्राप्ये स्तां गुणलब्धिके ॥ ७०९ ॥

ततोऽपि तद्वदेकैक[2]संहारे प्राक्तने क्रमात् ।

यावत्फलावसानं स्यात् तावदेव मुहुः कृते ॥ ७१० ॥

व्याख्या—1. The mss. read : द्वयानन्तरन्नयः ।　2. A. देवैक

गुणलब्धिर्मुहुः स्यातां तत्सङ्ख्याव्यहरोचिते[1] ।
अन्योन्यहरणे शेषा ये ते भाज्यहराः क्रमात् ॥ ७११ ॥

तत्र भाज्योद्भवा भाज्या हारोत्थास्तु हरा मताः ।
तक्षणं हारभाज्याभ्यां गुणलब्ध्योरिहान्ततः ॥ ७१२ ॥

त्यक्तव्ये हारभाज्यात् ते स्वर्णक्षेपविपर्यये ।
रूपतुल्यमृणक्षेपं प्रकल्प्यैतत् प्रदर्श्यते[2] ॥ ७१३ ॥

365
'मार्तण्डा'-ख्यैरनेनापि यथोक्तमुपसंहरेत् ।
उपसंहृतवल्लीनां व्युत्क्रमेणोच्यते फलम् ॥ ७१४ ॥

0 1 4 9 10 67 259 94593
'न' 'कि' 'वि' 'धी' 'वश' 'सतां' 'धीशत्रु' 'बंळिशाद्वधः' ।
ओजपङ्क्तिर्गुणस्त्वेषां युग्मपङ्क्तिः फलम् भवेत् ॥ ७१५ ॥

हाराल्लब्धा गुणा भाज्याल्लब्धपङ्क्तिः फलं क्रमात् ।
इत्येव नियमोऽतोऽत्र भाज्याधिक्येऽन्यथा स्थितिः ॥ ७१६ ॥

मध्यस्थे गुणनैषां[3] द्विः स्वोर्ध्वाधःस्थफलं प्रति ।
एवं फलत्वमन्यस्य स्वोर्ध्वाधस्थगुणं प्रति ॥ ७१७ ॥

स्वोर्ध्वाधावस्थितौ हारशेषौ यौ तद्द्वयं प्रति ।
मध्यस्थभाज्यशेषस्य भाज्यत्वं स्यात् तथा द्विशः ॥ ७१८ ॥

हारशेषस्य हारत्वं तथान्यद् द्वितयं प्रति ।
ऋणक्षेपं[4] पुरोक्तं यद्रूपमेवेह सर्वतः ॥ ७१९ ॥

गुणगुण्यहरेष्वेव फले चान्योन्यता[5] क्रमात् ।
अथोच्यन्ते हरो भाज्यो गुणो लब्धिरिति क्रमात् ॥ ७२० ॥

2
तत्रादौ हारशेषोऽन्त्यः 'श्री'र्हारो भाज्यशेषकः ।
1 1 4
भाज्यश्च 'कि' ऋणक्षेपो गुणः 'कि', 'वे'ति[6] तत्फलम् ॥ ७२१ ॥

व्याख्या—1. A. हरोमिते 2. A. B. C. प्रदृश्यते
3. A. B. C. गुणतैषां 4. A. B. C. क्षेप
5. A. चान्यान्यतः 6. B. नेति

2 9
हारो द्वितीये 'धी'रेव भाज्यः स्वोपरि 'धी'रिह ।
1 4
गुणः प्राच्यः 'कि'मेवात्र तस्योपरि फलं तु 'वित्' ॥ ७२२ ॥

28 9
तृतीयेऽप्योपरि 'हरो' हारो, भाज्यः स एव 'धीः' ।
9 4
गुणस्तूपरि 'धी'रत्र 'विदे'वाधःस्थितं फलम् ॥ ७२३ ॥

28 9 912 58
'हर''धी'-'प्रियधी'-'होमा'-श्चतुर्थे, पञ्चमे पुनः ।
149 129 67 58
'धीवन्द्य'-'धीप्रिय'-'सती'-'होमाः', षष्ठे तु ते क्रमात् ॥ ७२४ ॥

149 576 67 259
'धीवन्द्य'-'तत्सम''सती''धीशत्रु',रथ सप्तमे ।
210389 576
'धीजगन्नूपुरं' हारो, भाज्यः स्यादिह 'तत्समः' ॥ ७२५ ॥

94593 259
गुणकारी 'बलिशवेधं' स्यात् 'धर्मराड्' फलम् ।
भाज्यशेषे यदा रूपं दृश्यते तद्विधिस्त्वयम् ॥ ७२६ ॥

हारशेषे यदा रूपं तदोक्तन्यायतो गुणम् ।
आनीय भाजकाच्छुद्धमिष्टः स्यात् तादृशो गुणः ॥ ७२७ ॥

भाज्यभाजकरूपावशेषौचित्यविपर्ययात् ।
उद्दिश्यते यदा क्षेपस्तदेत्थं साध्यतां गुणः ॥ ७२८ ॥

प्रोक्तभाज्यहरे रूपं धनक्षेपं यदोद्दिशेत् ।
115796
हारकात् त्यक्तशिष्टं तत् 'स्तब्धोऽसौ मायया' गुणः ॥ ७२९ ॥

फलं च भाज्यतस्त्यक्तमिष्टं तादृक् फलं भवेत् ।
रूपशेषगुणाप्तिघ्ने स्वेष्टक्षेपे स्वके उभे ॥ ७३० ॥

स्वस्वतक्षणशिष्टे वा साध्ये ते तादृशे सदा ।
लाघवाय गुणस्योने कुट्टाकार इतीरितः ॥ ७३१ ॥

2 9

हारो द्वितीये 'धी'रेव भाज्यः स्वोपरि 'धी'रिह ।

1 4

गुणः प्राच्यः 'कि'मेवात्र तस्योपरि फलं तु 'वित्' ॥ ७२२ ॥

28 9

तृतीयेऽधोपरि 'हरो' हारो, भाज्यः स एव 'धीः' ।

9 4

गुणस्तूपरि 'धी'रत्र 'विदे'वाधःस्थितं फलम् ॥ ७२३ ॥

28 9 912 58

'हर''धी'-'प्रियधी'-'होमा'-श्चतुर्थे, पञ्चमे पुनः ।

149 129 67 58

'धीवन्द्य'-'धीप्रिय'-'सती'-'होमाः', षष्ठे तु ते क्रमात् ॥ ७२४ ॥

149 576 67 259

'धीवन्द्य'-'तत्सम''सती''धीशाङ्',रथ सप्तमे ।

210389 576

'धीजगन्नूपुरं' हारो, भाज्यः स्यादिह 'तत्समः' ॥ ७२५ ॥

94593 259

गुणकारी 'बलिशवेधं' स्यात् 'धर्मराड्' फलम् ।

भाज्यशेषे यथा रूपं दृश्यते तद्विधिस्त्वयम् ॥ ७२६ ॥

हारशेषे यथा रूपं तथोक्तन्यायतो गुणम् ।

आनीय भाजकाच्छुद्धमिष्टः स्यात् तादृशो गुणः ॥ ७२७ ॥

भाज्यभाजकरूपावशेषौचित्यविपर्ययात् ।

उद्दिश्यते यथा क्षेपस्तथेत्थं साध्यतां गुणः ॥ ७२८ ॥

प्रोक्तभाज्यहरे रूपं धनक्षेपं यथोद्दिशेत् ।

115796

हारकात् त्यक्तशिष्टं तत् 'स्तब्धोऽसौ मायया' गुणः ॥ ७२९ ॥

फलं च भाज्यतस्त्यक्तमिष्टं तादृक् फलं भवेत् ।

रूपशेषगुणाप्तिघ्ने स्वेष्टक्षेपे स्वके उभे ॥ ७३० ॥

स्वस्वतक्षणशिष्टे वा साध्ये ते तादृशे सदा ।

लाघवाय गुणस्योने कुट्टाकार इतीरितः ॥ ७३१ ॥

[देशान्तरसंस्कारः]

लङ्कामेरुगरेखायामुज्जयिन्यादितस्ततः ॥ २८b ॥

[देशान्तरसंस्कारः]

लङ्कामेरुगरेखायामिति (I. 28b-34)—

[भूमेरवस्थानम्]

समवृत्तघनो व्योम्नि भूगोलोऽसौ व्यवस्थितः ।
धारणात्मिकया शक्त्या स्वया विश्वं बिभर्ति यः ॥ ७३२ ॥

ननु तिष्ठेत् कथं भूमिः खमध्येऽसौ निराश्रया ।
गुरुत्वान्नभसस्तस्याः पतनं न भवेत् कथम् ॥ ७३३ ॥

निराश्रयाणि द्रव्याणि पतन्त्येव गुरूण्यधः ।
विश्वत्रयोऽयं भूगोलो गरीयानेव सर्वतः ॥ ७३४ ॥

सरित्समुद्रशैलागा यत्र सन्ति च जङ्गमाः ।
सत्यं किन्त्विह भूगोलः खमध्यात् क्व नु सम्पतेत् ॥ ७३५ ॥

पतन्ति यानि वस्तूनि यत्र तत्र पतत्वसौ ।
अधः पतन्ति दृश्यन्ते सर्वा अपि विहायसः ॥ ७३६ ॥

समर्थयामहे तस्मादधःस्यात् पतनं भुवः ।
अत्रोच्यतेऽखिलं वस्तु पततीह यथा भुवि ॥ ७३७ ॥

तद्वन्नान्यत्र पतनं भूगोलस्य तु कल्प्यताम् ।
विश्वाश्रयोऽयं भूगोलो यतो विश्वम्भरैव भूः ॥ ७३८ ॥

पतनं सर्ववस्तूनां भूपृष्ठावधि दृश्यते ।
दिवः पतत्यास्तु भुवः प्रतिष्ठा न[1] क्वचिद्भवेत् ॥ ७३९ ॥

भूभृतामपि सर्वेषां भूपृष्ठे स्थितिरिष्यते ।
बिभ्रत्यनन्तदिग्दन्तिमुखानेतान्निराश्रयाः ॥ ७४० ॥

व्याख्या—1. B. प्रतिष्ठानं

पूर्वापरदिशोः कार्ये कर्म देशान्तरोद्भवम् ॥ २९a ॥

आधारा नावतिष्ठन्ते विनाऽधारान्तरं यतः ।
स्वशक्त्यैव ततो व्योम्नि कल्प्यतेऽवस्थितिर्भुवः ॥ ७४१ ॥

भूगोलादन्यतोऽधो दिक् नोपलभ्या पतेद्यतः ।
सर्वतोऽधोगतस्तस्माद् भूगोलः परिकल्प्यते ॥ ७४२ ॥

भूगोले सर्ववस्तूनि पतन्त्येव समन्ततः ।
न पुनः क्वापि भूगोलः सर्वतोऽधोगतो यतः ॥ ७४३ ॥

तत्रापि घनभूमध्यं स्वशक्त्या धारयेदधः ।
भूपृष्ठावयवान् सर्वान् नियम्य व्यस्तदिग्गतात् ॥ ७४४ ॥

भूपृष्ठावयवाः सर्वे गोलाधन्तिरितत्वतः ।
समन्तात् प्रतिबध्नन्ति मिथः पिपतिषां च ताम् ॥ ७४५ ॥

खमध्यात् पतनाभावो भूगोलस्य ततो ध्रुवः ।
गोलाकारत्वमप्यस्य समन्तात् समगौरवात् ॥ ७४६ ॥

न तिष्ठति क्वचित् किञ्चिदाश्रयेण विना यदि ।
तादृशोऽप्याश्रयोऽस्त्यस्य नभ एव निरन्तरम् ॥ ७४७ ॥

आश्रयाश्रयिभावश्च मिथो भूतेषु दृश्यते ।
मूर्तामूर्तविभागोऽपि तत्राकिञ्चित्करो भवेत् ॥ ७४८ ॥

धारयेत् प्रवहो मूर्तान् यदमूर्तो मरुद् ग्रहान् ।
स्थिरं स्वतो नभस्तद्वद् धारयेत् क्षितिमण्डलम् ॥ ७४९ ॥

अर्कादीनां यथा बिम्बं गरीयोऽपि च धारयेत् ।
विश्वाश्रयोऽयं भूगोलो मध्ये व्योम व्यवस्थितः ॥ ७५० ॥

मृदम्बुहुतभुग्वायुमयो गोलाकृतिस्ततः ।
याम्यमर्धं जलमयं सौम्यं तस्य च मृण्मयम् ॥ ७५१ ॥

जलार्धमध्ये नरको मृण्मध्ये च सुरालयः ।
नगराणि च चत्वारि पार्श्वस्थानि तयोर्द्वयोः ॥ ७५२ ॥

लङ्का सिद्धपुरं चैव यवकोटिश्च रोमकम् ।
भूवृत्तपादान्तरिता[1] स्थितिस्तेषां मिथो भवेत् ॥ ७५३ ॥

व्याख्या—1. A. न्तरिताः

[देशान्तरकालः]

खखदेवा भुवो वृत्तं, त्रिज्याप्तं लम्बकाहतम् ॥ २९b ॥
स्वदेशजं, ततः षष्ट्या हृतं चक्रांशकाहतम् ।
खखदेवहृतं भागाद्यन्तरं त्वक्षभागयोः ॥ ३० ॥
स्वदेशसमयाम्योदग्रेखायां देशयोर्ययोः ।
तदन्तरालदेशोत्थयोजनैः सम्मिते स्वके ॥ ३१ ॥
भूवृत्ते नाडिकैका स्यात् कालो देशान्तरोद्भवः ।
निमीलनान्तरं यद्वा स्वदेशसमरेखयोः ॥ ३२ ॥
देशान्तरभवः काल, इन्दोरुन्मीलनादपि ॥ ३३a ॥

[देशान्तरकालः]

राश्यंशादिविभागाः स्युर्भूगोलेऽपि भगोलवत् ।
घटिकात् समयाम्योदक् क्षितिजोन्मण्डलादयः ॥ ७५४ ॥
रेखारूपाश्च भूगोले कल्पनीया भगोलवत् ।
येन स्वदेशे भूपृष्ठे सुघटावक्षलम्बकौ ॥ ७५५ ॥
लम्बव्यासदलं वृत्तं स्वभूवृत्तं द्युवृत्तवत् ।
स्वभूवृत्तस्थमार्गेण कल्प्या देशान्तरस्थितिः ॥ ७५६ ॥
मेरुलङ्काश्रिता रेखा या तत्रोद्यति भास्करे ।
कल्याद्यहर्गणानीता ग्रहमध्या भवन्ति हि ॥ ७५७ ॥
ततः पूर्वापरदिशो देशान्तरयुतोनिताः ।
नाडीषष्ट्या स्वभूवृत्तं पर्येत्यर्कः परिभ्रमन् ॥ ७५८ ॥
स्वभूवृत्तस्य षष्ट्यंशं क्रामन् नाड्या तथैकया ।
न कालेन विना स्वल्पमपि देशं व्रजेदसौ ॥ ७५९ ॥
अतस्तद्देशभेदेन कालभेदः प्रकल्प्यते ।
अर्कोदयादेस्तद्भेदात् भिद्येतौदयिको ग्रहः[1] ॥ ७६० ॥

व्याख्या—1. A. भिद्यते यदि को ग्रहः

स्वभूवृत्तस्य षष्टयंशो यः षष्ट्यंशस्ततोऽपि वा ।
तस्य तद्भ्रमकालो यो घटीविघटिकादिकः ॥ ७६१ ॥

देशान्तराख्यः कालोऽसौ प्रतिदेशं प्रकल्प्यते ।
तच्छेदांशस्वभूवृत्तात् तस्याध्वा च प्रकल्पितः ॥ ७६२ ॥

शास्त्रीयैर्योजनैरेव प्रमितोऽसौ तदागतः ।
योजनैर्लौकिकैरेव प्रमितोऽर्थक्रियाकरः ॥ ७६३ ॥

तदर्थं समयाख्योदग्देशयोरक्षचापयोः ।
ज्ञाते भूपृष्ठगे भेदे वंशैर्वाथ निवर्तनैः[1] ॥ ७६४ ॥

लौकिकैर्योजनैरेव भूभागः प्रमितो भवेत् ।
स एव भूयः शास्त्रीयैर्योजनैरपि मीयताम् ॥ ७६५ ॥

चक्रांशकमितेऽक्षांशे खखदेवमिता [तु] भूः[2] ।
ज्ञातैरक्षान्तरांशैः सा कियतीत्यनुपाततः[3] ॥ ७६६ ॥

खखदेवहताक्षान्तरांशकाद् भगणांशकैः ।
लब्धैः स एव भूभागः शास्त्रीयैर्योजनैर्मितः ॥ ७६७ ॥

एवं लौकिकशास्त्रीययोजनानां[4] परस्परम् ।
सम्बन्धनियमे ज्ञाते ज्ञेया देशान्तरस्थितिः ॥ ७६८ ॥

अक्षान्तरसमानीतैः शास्त्रीयैर्योजनैर्मितः ।
सोऽयं निवर्तनाद्यैश्च मितो लौकिकयोजनैः ॥ ७६९ ॥

षष्टयंशेन स्ववृत्तस्य तुल्यो भवति चेत्तदा ।
सोऽपि प्रमाय संवेद्यो लौकिकैरेव योजनैः ॥ ७७० ॥

ततोऽत्र नाडिकैका स्यात् कालो देशान्तरोद्भवः ।
स्वभूवृत्तस्य षष्टयंशं तत्षष्टयंशं ततोऽपि वा ॥ ७७१ ॥

शास्त्रीययोजनमितं लौकिकैरपि मीयताम् ।
देशान्तरभवः कालो नाड्याद्यैर्लभ्यते ततः ॥ ७७२ ॥

व्याख्या—1. A, विवर्तनैः 2. A. C. मिता प्रभूः; B. मिता-भूः
3. A. क्रियतेत्यनुपातत: 4. A. B. ह्रां for नां

[देशान्तरकालस्य धनर्णत्वम्]

प्रागेव दृश्यते प्रत्यक्, पश्चात् प्राच्यां ग्रहः सदा ॥ ३३b ॥
देशान्तरघटीक्षुण्णा मध्या भुक्तिर्द्युचारिणाम् ।
षष्ट्या भक्तमृणं प्राच्यां रेखायाः, पश्चिमे धनम् ॥ ३४ ॥

स्वदेशात् समरेखान्ते लौकिकैरेव योजनैः ।
प्रमिते स तथाऽऽनीतः कालो देशान्तरोद्भवः ॥ ७७३ ॥

प्राक् पश्चात् समरेखातो निजदेशोदयावधिः ।
निमीलनान्तरं यद्वा स्वदेशसमरेखयोः ॥ ७७४ ॥

देशान्तरभवः कालो यदि नोन्मीलनान्तरम् ।
ग्रहयोः समकालत्वं स्वदेशसमरेखयोः ॥ ७७५ ॥

स्याविन्द्वोरिव नार्कस्य भेदतो लम्बनाविना ।
कालो देशान्तरस्येन्दोस्तदुक्तो ग्रहणान्तरात् ॥ ७७६ ॥

देशान्तरेणैव परं स्वदेशसमरेखयोः ।
इन्दोर्ग्रहणभेदोऽयं भवेन्नान्येन केनचित् ॥ ७७७ ॥

निमीलनान्तरात्तत्र यदि वोन्मीलनान्तरात् ।
देशान्तरभवः कालः सुसूक्ष्मो ज्ञायते ततः ॥ ७७८ ॥

[देशान्तरकालस्य धनर्णत्वम्]

प्राग्देशसमरेखातः प्रागेवाभ्युदितो ग्रहः ।
अतो ग्रहणकालोऽयं वर्धतेऽर्कोदयावधेः ॥ ७७९ ॥

निमीलनादिकं पश्चात् तत एवात्र दृश्यते ।
प्रत्यग्देशेषु च ततः पश्चादेवोदयं व्रजेत् ॥ ७८० ॥

निमीलनादिकालोऽयं स्वल्पस्तत्रोदयावधिः ।
अतोऽत्र समरेखातः पूर्वं दृश्येत तद्द्वयम् ॥ ७८१ ॥

अतोऽत्र समरेखातः प्राक्प्रतीचोः स्वदेशयोः ।
ऋणं धनं च क्रियते देशान्तरगतिर्ग्रहे ॥ ७८२ ॥

[ग्रहाणां कल्यादिध्रुवाः]

—4°　45′ 46″
षड्वेदेष्वब्धिवेदास्तु विलिप्तादिध्रुवो विधोः ।
—3ʳ 29° 17′ 5″
प्राणात्यष्ट्यङ्कनेत्राग्नितुल्यं चन्द्रोच्चमध्यमम् ॥ ३५ ॥

—11ʳ 17° 47′
सप्तसागरशैलेन्दुभवा लिप्तादयोऽसृजः ।
—36′
षट्त्रिंशल्लिप्तिकाः शोध्या विदो, जीवे तु योजयेत् ॥ ३६ ॥

+12° 10′
पङ्क्त्यर्कतुल्यलिप्तादि, सिते राशिः षडंशकाः ।
+1ʳ 6° 13′　　　　+11ʳ 17° 20′
विश्वतुल्याः कलाश्च स्वं, नखात्यष्टिभवाः शनेः ॥ ३७ ॥

+6ʳ 22° 20′
पाते तु मण्डलाच्छुद्धे नखाङ्कतिरसा अपि ॥ ३८a ॥

[नवमयुगादौ[1] ध्रुवाः]

कल्यादिध्रुवका ह्येते युगभोगसमन्विताः ॥ ३८b ॥

कृतदेशान्तरगतिर्ग्रहमध्यः स्फुटोऽपि वा ।
निजदेशे भवत्येष मध्यमार्कोदयावधिः ॥ ७८३ ॥

इति ॥

[ग्रहाणां कल्यादिध्रुवाः]

षड्वेदेष्वब्धीति (I. 35-38a)—

कल्यादौ न निरंशत्वं भगणादेर्ग्रुचारिणाम् ।
गतिभेदात्तु दृक्सिद्धास्तत्रैषां स्युर्ध्रुवास्ततः ।' ७८४ ॥

मूलम्— 1. This refers to a contemporary date of the author Nīlakaṇṭha Somayāji (born A.D. 1444), who takes 576 years as a 'minor' *yuga* (verse 39, below). Thus, eight *yugas* ($8 \times 576 = 4608$ years) from the beginning of Kali will end and the ninth *yuga* will commence at the close of the Kali year 4608 (A.D. 1507-8).

576
तत्तद्युगे ध्रुवा ज्ञेयाः, षडश्वेष्वब्दकं युगम् ।
7500
भगणात् खखभूताश्वैर्युगभोगस्त्ववाप्यते ।
अष्टघ्नयुगभोगाः स्वमतः कल्यादिजे ध्रुवे ॥ ३६ ॥

अत एवायमाचार्यो भास्कराभिमतं युगम् ।
स्वीकर्तुं भगणानेव परिवर्तितवानिह ॥ ७८५ ॥

[नवमयुगादौ ध्रुवाः]

इच्छाराशिर्विभक्तश्चेद् येन केनापि राशिना ।
तत्र लब्धफलाभ्यस्ता तद्भुक्तिर्भुक्तिरीप्सिता ॥ ७८६ ॥

7500
युगपर्ययतः खाभ्रभूताश्वैर्यद् द्युचारिणाम् ।
लभ्यते [1]युगभोगोऽसावष्टभिर्गुणितः स च ॥ ७८७ ॥

कल्यादिध्रुवसंयुक्तो नवमादौ ग्रहध्रुवाः ।
अर्को निरंशतां याति तत्र, नेन्द्वादयोऽखिलाः ॥ ७८८ ॥

युगसंख्याहता भोगा ध्रुवास्तत्तद्युगोद्भवाः ।
576
षडश्वेष्वब्दमर्कस्य निरंशं तु[2] युगं भवेत् ॥ ७८९ ॥

210389
नवाष्टवह्निवियदिन्दुश्वितुल्यं च तद्दिनम् ।
तच्चाष्टभिर्विनिहतं खण्ड आचार्यसम्मतः ॥ ७९० ॥

ध्रुवान् निबद्धवान् यत्र शास्त्रकारः स्वयं बृहान् ।
[3]युगादेर्नवमात् तस्मात् प्रारब्धो दिनसञ्चयः ॥ ७९१ ॥

खण्डशेषतयाऽऽचार्यसम्मतो ग्रहमध्यमे ।
ततस्त्रैराशिकानीता[4] ग्रहमध्यास्ततो ध्रुवाः[5] ॥ ७९२ ॥

व्याख्या—1. B. युगभेदो 2. A. निरंशस्तु
3. A. युगादि 4. A. त्रैराशिकं नीताः
5. B. मध्याः स तद्ध्रुवाः

[गुणकारहाराणां लघूकरणवासना]

लाघवार्थं तनूकार्यौ गुणहारावपि क्वचित् ।
यावृङ्नियममाश्रित्य गुणहारकयोः स्थितिः ॥ ७९३ ॥

तत्र तावृङ्नियमतस्तत्र कार्यौ च तावुभौ ।
राशिनैकेन हतयोर्हतयोरपि वा द्वयोः ॥ ७९४ ॥

केनापि हत्वा युगपत् केनाप्यन्येन भक्तयोः ।
गुणहारकयोः पूर्वो नियमो नैव हीयते ॥ ७९५ ॥

गुणं प्रकल्प्य स्वधिया हारके तेन संहृते ।
तद्गुणेनोद्धृतो हारो गुणस्तस्य स्वधीकृतः ॥ ७९६ ॥

गुणकारेऽथवा मत्या हृते तद्धारकोद्धृते ।
तद्धारको मतिस्तस्य गुणकारः प्रकल्प्यते ॥ ७९७ ॥

एवं त्रैराशिकात् सिद्धौ गुणहारौ लघूकृतौ ।
निश्शेषत्वे तयोस्ताभ्यां नीतमिच्छाफलं स्फुटम् ॥ ७९८ ॥

निश्शेषत्वे तयोरावापोद्वापाभ्यां च कस्यचित् ।
अत्यल्पत्वाद् यदा हारे लब्धे शिष्टमुपेक्षितम् ॥ ७९९ ॥

शेषस्य त्यज्यमानत्वात् तदा हीनांशको हरः ।
हारे हीनांशके लब्धफलस्याधिकता भवेत् ॥ ८०० ॥

ततस्तत्परिहारार्थं त्याज्यं किञ्चन तत्फलात् ।
यदा तु ह्रियते भागः किञ्चित् क्षिप्त्वा निरंशकम् ॥ ८०१ ॥

शेषस्य गृह्यमाणत्वादधिकांशो हरस्तदा ।
हारेऽधिकांशे लब्धं तु फलं हीयेत वास्तवात् ॥ ८०२ ॥

तदर्थं किञ्चन क्षेप्यं तल्लब्धे येन वास्तवम् ।
हारे हीनांशके त्याज्यं क्षेप्यं तत्राधिकांशके ॥ ८०३ ॥

अधिकांशे गुणे त्याज्यमूनांशे क्षिप्यते च तत् ।
द्वितीयहारकेणाप्तं स्फुटमिच्छाफलं यतः ॥ ८०४ ॥

हारेण महताप्यस्तो गुणः स्वमतिकल्पितः ।
तत्र लब्धेन हारेण गुणोऽपि च महान् हतः ॥ ८०५ ॥

तुल्यौ स्यातां यदा तत्र निश्शेषहरणं भवेत् ।
मतिघ्नो हारकस्तत्र प्रमाणं तत्फलं पुनः ॥ ८०६ ॥

अंशो न्यूनोधिको वेच्छाराशिरेकोऽत्र हारयोः ।
यदि न्यूनोऽधिको वांशो हारे मत्याहते भवेत् ॥ ८०७ ॥

तदत्र पूर्वगुण्यस्य कियान्न्यूनाधिकांशकः[1] ।
इति त्रैराशिकेनात्र लभ्यं न्यूनाधिकं फलम् ॥ ८०८ ॥

ननु पूर्वगुणाभ्यस्ते गुणे स्वमतिकल्पिते ।
तेनैव कल्पितगुणेनाभ्यस्तो हारको मतः ॥ ८०९ ॥

सोऽयं मतिफलाभ्यस्तपूर्वहारसमो मतः ।
सत्यं मत्याप्तहारस्याऽत्राधिकोनांशसम्भवात् ॥ ८१० ॥

अधिकोनांशकस्यास्य हारान्मतिगुणाविह ।
महागुणोद्धृते न्यूनाधिकांशेन समत्वतः ॥ ८११ ॥

प्रमाणराशिर्मत्यैव गुणितो हारको महान् ।
गुणेन महता भक्ते फलन्यूनाधिकांशकः ॥ ८१२ ॥

गुण्य एको [2]भवेन्न्यूनाधिकांशस्यास्य च स्मृतः[3] ।
हारस्त्वाद्यो मतिहतो चान्यो[4] मतिफलाभिधः ॥ ८१३ ॥

गुणकारे मतिफले गुणे हारे च कल्पिते ।
गुणे महति गुण्ये च प्रक्रियेयं न भिद्यते ॥ ८१४ ॥

इत्थं तनूकृतैर्गुण्यगुणहारैस्त्रिभिः पुनः ।
उपायलाघवाद् वेद्यमिच्छाराशेः फलं बुधैः ॥ ८१५ ॥

सर्वत्रेत्थमुपायानां लाघवे सम्भवत्यपि ।
गुणयन्तीह ये केचिद् यत्नगौरवमाश्रिताः ॥ ८१६ ॥

ते सम्भवल्लघूपायदोषान्निग्रहभागिनः ।

576

एतत्सर्वमभिप्रेत्य षडश्वेष्वब्बकं युगम् ॥ ८१७ ॥

व्याख्या—1. C. धिकांशका: 2. B. C. मतेर्न्यूना

3. C. स्मृतम् 4. B. हृतोऽथान्यो

[ग्रहाणां मन्दोच्चा:]

127′ 220′ 172′ 80′ 240′

स्वररवयः खाकृतयो द्विनगभुवोऽशीतिरभ्रजिनाः ।

78′

भौमान्मन्दोच्चांशा, वसुतुरगा भास्करस्यापि ॥ ४० ॥

[॥ इति तन्त्रसंग्रहे मध्यमप्रकरणं नाम प्रथमोऽध्यायः ॥]

आचार्येण स्वयं प्रोक्तं तद्ध्रुवाश्च द्युचारिणाम् ।
युगादेर्नवमात् तस्मादतीतविनसञ्चयात् ॥ ८१८ ॥

स्वल्पाभ्यां गुणहाराभ्यामानीता भगणादयः ।
तदीयध्रुवसंयुक्ता मध्यमाः स्युर्द्युचारिणाम् ॥ ८१९ ॥

[ग्रहाणां मन्दोच्चांशाः]

स्वररवय इति[1] (I. 40)—

2ʳ—18° 4ʳ—7° 7ʳ—10° 5ʳ—22° 2ʳ—20°

[2] दोर्म्यां प्राज्ञै:', 'स्थानं स्वं', 'ज्ञेयं स', 'त्रिराशि', 'निष्ठाग्रै:' ।

8ʳ—0°

'अनुविन'-मुच्चमिनाद्ये,रनुक्रम् आराद्विशीघ्र्यम् इनमध्यम् ॥ ८२० ॥

इत्येष परक्रोडावासद्विजवर[3]समीरितो योऽर्थ: ।
स तु तन्त्रसंग्रहस्य प्रथमेऽध्याये मया कथितः ॥ ८२१ ॥

[इति तन्त्रसंग्रहस्य पद्यव्याख्यायां
मध्यमप्रकरणं नाम
प्रथमोऽध्याय: ।]

व्याख्या—1. C. adds : 'मूल-श्लो०'

2. A. B. C. om. दोर्म्यां ; it is supplied from this well-known verse.

3. C. om. द्विजवर

अथ द्वितीयोऽध्यायः

स्फुटप्रकरणम्

[केन्द्रं पदव्यवस्था च]

स्वोच्चोनो विहगः केन्द्रं, तत्र राशित्रयं पदम् ।
ओजे पदे गतैष्याभ्यां बाहुकोटी, समेऽन्यथा ॥ १ ॥

अथ द्वितीयोऽध्यायः

[मङ्गलाचरणम्]

यत्सेवनतः सद्यः सर्वज्ञत्वं लभेत मूर्खोऽपि ।
कुन्देन्दुस्वच्छतनुं सरस्वतीं तां नमामि सदा ॥ १ ॥

मध्यमानयनोपायमित्थं प्रोच्य सविस्तरम् ।
गतिशेषतया वच्मि स्फुटकर्म द्युचारिणाम् ॥ २ ॥

[केन्द्रं पदव्यवस्था च]

स्वोच्चोन इति (II. 1)—

मिथः सम्बन्धयोर्भिन्नकेन्द्रयोर्वृत्तयोर्द्वयोः ।
स्वान्येन मितयोर्भेदो विज्ञेयः स्फुटकर्मणा ॥ ३ ॥

केन्द्रद्वयावभेदी यो मार्ग एकस्तयोर्द्वयोः ।
नीचोच्चमार्गसंज्ञेयो नीचोच्चद्वितयाश्रितः ॥ ४ ॥

नीचोच्चमार्गादुभयोर्वृत्तयोः केन्द्रभेदिनो ।
मार्गो समतिरश्चीनो ततो दूरविभेदिनो ॥ ५ ॥

विप्रकर्षः परस्तत्र वृत्तयोरुभयोस्ततः ।
तत्पार्श्वयोः सन्निकृष्य[1]माणस्त्वावुभयोः क्रमात् ॥ ६ ॥

अविप्रलिप्तभागं प्रत्योन्मुख्यं सन्निकृष्टता ।
वृत्तयोर्विवरं स्यांशे क्वापि सम्बन्धयोर्मिथः ॥ ७ ॥

वर्धते वृत्तपादेन भूयस्तेनैव हीयते ।
भूयोऽपि वर्धते तेन तेनैव क्षीयते पुनः ॥ ८ ॥

वर्धते क्षीयते च द्विरेकस्मिन्नेव पर्यये ।
वृत्तयोर्विवरं तस्मात्तिर्यगूर्ध्वमधोऽपि वा ॥ ९ ॥

राशित्रयात्मकं वेद्यं पदं तन्मण्डलेऽखिले ।
वृत्तान्तरोत्थयोर्वृद्धिक्षययोर्विवराश्रयः ॥ १० ॥

वृत्तपादः पदं तस्मादेकैकोऽपि भवेदिह ।
वृत्तावयवसम्पातात् पादान्ते परमान्तरात् ॥ ११ ॥

साध्यमत्रानुपातेन वृत्तेष्टावयवान्तरम् ।
दोर्ज्या प्रवृत्ता गोलान्तात् कोटिज्या त्वयनान्ततः ॥ १२ ॥

ते उभे विप्रकर्षौ स्तः स्वेष्टदेशस्य तद्द्वयात् ।
सर्वत्रापि पदे तादृग्विप्रकर्षस्य सम्भवात् ॥ १३ ॥

मिथो दोःकोटिरूपे ज्ये पदे सर्वत्र सङ्गते ।
समतिर्यग्गतत्वेन दोःकोटित्वं मिथस्तयोः ॥ १४ ॥

गोलायनान्तौ पदयोरोजयोरधऊर्ध्वयोः[2] ।
गतगन्तव्यता तत्र ततो दोःकोटिचापयोः ॥ १५ ॥

युग्मयोस्तु विपर्यासाद् विज्ञेया गतगम्यता ।
दोश्चापोनो वृत्तपादः कोटीचापोऽन्यथापि वा ॥ १६ ॥

इति ।

व्याख्या—1. B. सन्निकर्ष्य   2. C. ऊर्ध्वगौ

[ज्याग्रहणं चापीकरणं च]

[तत्र चतुरश्रक्षेत्रेण वृत्तानयनम्]

क्षेत्रेण चतुरश्रेण वृत्तस्यानयनं यथा ।
तत्रादौ तद्भुजातुल्यं व्यासार्धं तस्य कल्पयेत् ॥ १७ ॥

दिक्सूत्रद्वितयेनैतच्चतुर्धा प्रविभज्यते ।
क्षेत्रे तथाकृते खण्डाश्चत्वारः स्युश्चतुर्भुजाः ॥ १८ ॥

केन्द्रात्तद्बाहुमध्यस्पृग् व्यासार्धमपि कल्पयेत् ।
अतश्चतुर्णां खण्डानां भुजा व्यासार्धसम्मिता ॥ १९ ॥

क्षेत्रकेन्द्रात् पुनस्तेषां कर्णः कोणावधिर्मतः ।
दिक्सूत्राग्रद्वयस्पृष्टः कर्णस्तत्रापरोऽपि च ॥ २० ॥

केन्द्रात् कोणावधिः कर्णो भूमित्वेनात्र कल्पितः ।
तत्कर्णाग्रद्वयाद् दिक्सूत्राग्रान्ते च भुजे उभे ॥ २१ ॥

ततश्चतुर्भुजक्षेत्रे प्रत्येकं त्रिभुजद्वयम् ।
लम्बो द्वितीयकर्णार्धप्रमितस्त्रिभुजद्वये ॥ २२ ॥

तत्राबाधा प्रमाणं स्याल्लम्बमूलाद् भुजावधि ।
भुजार्धं तत्फलं लम्बाबाधयोः कर्णवत् स्थितम् ॥ २३ ॥

व्यासार्धरहिता भूमिरिच्छाराशिश्च कल्प्यते ।
तत्र लब्धफलं नीत्वा कोणतः पार्श्वयोर्द्वयोः ॥ २४ ॥

तयोर्द्वोःखण्डयो रेखां विलिखेत् कर्णरूपिणीम् ।
ततो द्विगुणलब्धोनभुजातुल्यं भुजाष्टकम् ॥ २५ ॥

ततो दोर्दलदोर्मध्यस्फुटव्यासार्धवर्गयोः ।
योगमूलं भवेत् कर्णः केन्द्रादष्टाश्रकोणगः ॥ २६ ॥

अथाष्टाश्रभुजार्धोत्थवर्गव्यासार्धवर्गयोः ।
भेदात् कर्णोद्धृतं यत् स्यात् तदाबाधान्तरं भवेत् ॥ २७ ॥

व्यासार्धवर्गदोरर्धवर्गयोर्यत्तदन्तरम् ।
तदेव घ्नतदाबाधाद्वयवर्गान्तरं भवेत् ॥ २८ ॥

कर्ण आबाधयोर्योगस्तेन वर्गान्तरात् तयो: ।
अन्तरं स्याद् यतो वर्गान्तराद् योगाप्तमन्तरम् ॥ २९ ॥

आबाधयोर्युति: कर्ण: स स्वाबाधान्तरोनित: ।
अर्धीकृतोऽल्पा स्वाबाधा भुजार्धं तस्य तु श्रुति: ॥ ३० ॥

ते प्रमाणफले स्यातां कर्णो व्यासार्धवर्जित: ।
इच्छाराशिस्तदेकदेशस्त[स्मात् त]च्छ्रुति:[1] फलम् ॥ ३१ ॥

तदाबाधैकदेशस्य का श्रुतिस्त्विति या श्रुति: ।
तां कोटिपार्श्वयोर्नीत्वा कुर्याद्रेखां तु पूर्ववत् ॥ ३२ ॥

क्षेत्रं तत: षोडशाश्रं ततो द्वात्रिंशदश्रकम् ।
यदा सर्वत्र कोणेषु भुजामध्यं भवेत्तथा ॥ ३३ ॥

प्रोक्तमार्गेण कर्तव्यं वृत्ताकृति भवेत्तत: ।
वृत्तं तदिष्टव्यासेन [हृत्वैतद् व्याससंहृतम्][2] ॥ ३४ ॥

इष्टव्यासस्य वृत्तं स्यादिति वृत्तं समानयेत् ।
लम्बाबाधादिकं सर्वं पश्चात् स्पष्टीभविष्यति ॥ ३५ ॥

[वर्ग-मूल-क्रियाभिर्विना वृत्तपरिध्यानयनम्]

वर्गमूले विना यद्वा व्यासत: परिधिं नयेत् ।
तदर्थं कल्पयेत् क्षेत्रं व्यासतुल्यचतुर्भुजम् ॥ ३६ ॥

तदन्त: कल्पयेद् वृत्तं दोर्मध्यस्पृष्टनेमिकम् ।
तदन्तर्वृत्तमप्येकं दोर्मध्याक्रान्तनेमिकम् ॥ ३७ ॥

वृत्तमध्ये च दिक्सूत्रद्वितयं कल्पयेत् तथा ।
वृत्तनेमिभुजामध्यसम्पातस्थतदग्रकम् ॥ ३८ ॥

दिक्सूत्राग्राच्चतुर्बाहुकोणान्तं यद् भुजादलम् ।
समत्वेन विभक्तेऽस्मिन् कुर्याद् बिन्दून् बहूनपि ॥ ३९ ॥

बह्वी रेखा लिखेद् वृत्तकेन्द्रात् तद्बिन्दुगामिनी: ।
कर्णरेखास्तु तां केन्द्राद् दोर्मध्यान्ता च कोटिका ॥ ४० ॥

व्याख्या—1. Mss. read देशस्तच्छ्रुति: 2. Mss. read हृत्वैतद् व्यसनं हृतम्

कोटिकर्णाग्रविवरभुजाभागाश्च तद्भुजाः ।
एकैकभागाधिकास्ते कर्णानां स्युर्यथोत्तरम् ॥ ४१ ॥

व्यासार्धस्वभुजाकृत्योरिष्टकर्णौ युतेः पदम् ।
तत्कर्णव्यासवलयोर्वर्गान्तरपदं भुजा ॥ ४२ ॥

तत्राद्यकर्णविक्सूत्राग्रयोर्विवरतो हतात् ।
व्यासार्धेन स्वकर्णाप्तं ततो यल्लभ्यते फलम् ॥ ४३ ॥

कर्णव्यत्यस्तविक्सूत्राग्रान्तात् कर्णान्तरं तु तत् ।
कोटिः सा तद्भुजाकर्णशेषः सम्पाततस्तयोः ॥ ४४ ॥

कर्णविक्सूत्रयोरग्रविवरं चापि तच्छ्रुतिः ।
इच्छात्मकमिदं त्र्यश्रक्षेत्रं यत्त्वन्यदीदृशम् ॥ ४५ ॥

व्यासार्धकर्णविवरभुजं व्यासार्धकोटिकम् ।
व्यासार्धकर्णविवरदोःखण्डभुजकं भवेत् ॥ ४६ ॥

प्रमाणं त्र्यश्रमुद्दिष्टं तुल्याकारतया द्वयोः ।
यस्य दोःकोटिकर्णेषु व्यस्तो यावतिथात् स्थितिः ॥ ४७ ॥

तदन्यत्र्यश्रकर्णः स्यात् तस्य तावतिथास्ततः ।
आद्यक्षेत्रस्य कर्णोऽपि व्यस्तदिक्कतया स्थितः ॥ ४८ ॥

क्षेत्रान्तरभवात् कर्णाद् यत्र व्यत्यस्तदिक् स्थिता ।
भुजाकोट्योरन्यतरात् क्षेत्रे तुल्याकृतीकृते ॥ ४९ ॥

अत्र प्रमाणक्षेत्रस्य कोटिर्विक्सूत्रसंज्ञिता ।
इच्छाक्षेत्रस्य कर्णोऽस्याः कोटेर्व्यत्यस्तदिग्गता ॥ ५० ॥

प्रमाणक्षेत्रकर्णश्च व्यस्त इच्छाद्यकोटितः ।
ततस्त्रैराशिकान्नेयमिच्छाक्षेत्रगतं फलम् ॥ ५१ ॥

तृतीयमपि च त्र्यश्रं यत्तु दिक्सूत्रकर्णकम् ।
इच्छात्र्यश्रगता कोटिस्त्र्यश्रस्यास्य भुजोदिता ॥ ५२ ॥

प्रमाणक्षेत्रकर्णे तु तद्भुजा यत्र सम्पतेत् ।
तत्सम्पातात् क्षेत्रकेन्द्रान्तरालान्तस्य कोटिका ॥ ५३ ॥

चतुर्भुजभुजाखण्डद्वयसम्मितबाहुकम् ।
द्वितीयकर्णरेखाख्यकर्णदिक्सूत्रकोटिकम् ॥ ५४ ॥

क्षेत्रं यच्च प्रमाणं तत्प्रमाणक्षेत्रमुच्यते ।
द्वितीयकर्णविवरमाद्यकर्णाग्रतोऽपि यत् ॥ ५५ ॥

सा कोटिस्तच्छ्रुतिः खण्डो द्वितीयश्चतुरश्रगः ।
द्वितीयकोट्याः कर्णस्य शेषः सम्पाततो भुजा ॥ ५६ ॥

इच्छाक्षेत्रं द्वितीयं तत् त्र्यश्रं ताभ्यां च तत्फलम् ।
यद् द्वितीयभुजाखण्डं चतुरश्रे तु कल्पितम् ॥ ५७ ॥

व्यासार्धनिहतात् तस्मात् कोटिस्तत्कर्णसंहृता ।
द्वितीयकर्णरेखा च कर्णत्वेनात्र कल्पिता ॥ ५८ ॥

सा कोटिस्तु भुजाकर्णः प्रथमः कर्ण एव तत्[1] ।
तद्भुजाग्रावधिः केन्द्रात्तत्कोटिरपि कल्प्यते ॥ ५९ ॥

एवं त्र्यश्रद्वयं कल्प्यं प्रतिबोःखण्डमत्र तु ।
आसन्नकर्णविवरं पूर्वकर्णाग्रतस्तु यत् ॥ ६० ॥

आसन्नकर्णव्यत्यस्तदिग्गतः कोटिका भवेत् ।
पूर्वकर्णाग्रतः स्वोर्ध्वकर्णान्ता बहवो हताः ॥ ६१ ॥

दिक्सूत्राग्राच्चतुर्बाहुकोणान्ताः कल्पयेच्च ताः ।
चतुर्भुजभुजाखण्डान् दिक्सूत्रगुणितांस्ततः ॥ ६२ ॥

ऊर्ध्वोर्ध्वकर्णैर्विभजेत् तत्र लब्धफलं तु यत् ।
पूर्वकर्णाग्रतः स्वोर्ध्वकर्णव्यस्तदिगन्तरम् ॥ ६३ ॥

इच्छात्र्यश्रगता कोटिः सैषान्यत्र भुजा भवेत् ।
तद्भुजाकर्णसम्पातात् तत्कोटिः केन्द्रगामिनी ॥ ६४ ॥

स्वपूर्वकर्णस्तत्कर्णस्तत्तु त्र्यश्रं तथाविधम् ।
ऊर्ध्वत्रैराशिके त्वेतत्प्रमाणं त्र्यश्रमिष्यते ॥ ६५ ॥

यदीच्छात्रिभुजं प्रोक्तं वृत्तान्तः कल्पयेच्च तत् ।
व्यासार्धं गुणकस्तत्र पूर्वकर्णोऽपि हारकः ॥ ६६ ॥

व्याख्या—1. B. एव च

लब्धा तत्कर्णविवरपरिध्यंशोत्थशिञ्जिनी ।
चतुर्भुजभुजाखण्डाद् व्यासार्धेन द्विराहतात् ॥ ६७ ॥

पूर्वोर्ध्वकर्णघाताप्ता भवन्त्यर्धगुणास्ततः ।
दिक्सूत्रतो ये दोःखण्डाश्चतुरश्रे व्यवस्थिताः ॥ ६८ ॥

तदग्रास्तास्तु या कर्णरेखाः केन्द्रात् समुद्गताः ।
तदन्तरालोत्थपरिध्यंशार्धज्याः क्रमादिमाः ॥ ६९ ॥

कर्णाग्रविवरांशत्ववशाद् वा धनुरंशकाः ।
चतुरश्रे भुजाखण्डाः तत्र गुण्याः सदा समाः ॥ ७० ॥

व्यासार्धवर्गो गुणकः सर्वस्यापि[1] समोऽत्र तु ।
पूर्वोर्ध्वकर्णसंवर्गो नानारूपस्तु हारकः ॥ ७१ ॥

पूर्वोर्ध्वकर्णयोर्वर्गयोगार्धं वा स हारकः ।
पृथक् तत्कर्णवर्गाभ्यां विभक्ते यत्फलद्वयम् ॥ ७२ ॥

तद्योगार्धमितं कर्णवर्गदलोद्धृतं फलम् ।
तत्राद्यकर्णवर्गेण तद्धतो ह्रियते यदा ॥ ७३ ॥

तदा दोःखण्ड एव स्यात् तुल्यत्वाद् गुणहारयोः ।
यदान्त्यकर्णवर्गाप्तं दोःखण्डार्धमितं तु तत् ॥ ७४ ॥

व्यासार्धवर्गो द्विगुणो ह्यन्त्यवर्गो भवेद् यतः ।
हारेण द्विगुणेनाप्तो गुण्यार्धप्रमितं फलम् ॥ ७५ ॥

यत्पूर्वपूर्वकर्णेन विहृतं फलमादिमम् ।
यदप्यूर्ध्वोर्ध्वकर्णेन विभक्तं फलमन्तिमम् ॥ ७६ ॥

तयोरन्तरमेवात्र फलभेदाय कल्पते ।
फलानामितरेषां तु हारकस्य समत्वतः[2] ॥ ७७ ॥

यद् द्वितीयाद्युपान्त्यान्तं फलं तत्तु न विद्यते ।
कर्णवर्गेण पूर्वेण हरणादुत्तरेण च ॥ ७८ ॥

आद्यन्त्यफलयोरेव तत्र भेदो भवेत् स्फुटम् ।
तत्पुनर्बाहुखण्डार्धं न कदाचित्ततोऽधिकम् ॥ ७९ ॥

व्याख्या—1. C. सर्वत्रापि 2. A. C. समत्वकम्

आद्यहारेण विहृते भुजार्धप्रमितं तु तत् ।
तद्योगार्धहृते चापो न दोःखण्डमितं फलम् ॥ ८० ॥

अर्धचापोनविवरं खण्डचापमितं तु तत् ।
फलान्तरं तदेवात्र न कदाचित्ततोऽधिकम् ॥ ८१ ॥

दोःखण्डाणुत्ववशतः शक्यं चैतदुपेक्षितुम् ।
यः कश्चित्कर्णवर्गोऽत्र हारकः कथ्यते तदा ॥ ८२ ॥

चापमानान्त्यकर्णस्य वर्गेण हरणं त्विह ।
व्यासार्धवर्गगुणितात् तत्तद्दोःखण्डवर्गतः ॥ ८३ ॥

तदीयकर्णवर्गेण लभ्यते तत्र यत्फलम् ।
कर्णान्तरालसम्भूतपरिध्यंशस्य शिञ्जिनी ॥ ८४ ॥

दिक्सूत्राविष्टकर्णान्तभुजाखण्डस्य या कृतिः ।
गुणहारान्तरं तत् स्याद् गुणो व्यासार्धजाकृतिम् ॥ ८५ ॥

हृत्वा त्विष्टदोःखण्डं हारेण विभजेत् फलम् ।
तत्तद्दोःखण्डतस्त्यक्त्वा शिष्टा स्यादिष्टशिञ्जिनी ॥ ८६ ॥

[1]गुणहारान्तरहताद् गुण्येन ह्रियते यदि ।
अल्पत्वाद् गुणकारस्य तत्फलं महदेव हि ॥ ८७ ॥

गुणकारहतं भूयो हारकेण विभज्यते ।
तत्र लब्धफलं यत्तत् स्फुटं शोध्यफलं भवेत् ॥ ८८ ॥

गुणहारान्तरहतं पृथक् शोध्यफलं हरेत् ।
हारकेणैव यल्लब्धं गुणलब्धफलात् त्यजेत् ॥ ८९ ॥

स्फुटं शोध्यफलं तत्र यदि वा परिकल्पयेत् ।
गुणस्य हरणत्वं तत्फलस्यापि च गुण्यताम् ॥ ९० ॥

गुणहारान्तरहताद् गुण्यात् तत्तत्फलादपि ।
गुणेन यानि लभ्यानि गुण्ये क्षेप्यानि तान्यपि ॥ ९१ ॥

व्याख्या—1. A. Hapl. om. after गुण to गुण, four lines below.

आधिक्ये गुणकारस्य हारादेव विधिर्मतः ।
अल्पत्वे गुणकारस्य युग्मान्येव क्षिपेत् पृथक् ॥ ९२ ॥

ओजानि गुण्याच्छोध्यानि प्रायः सूक्ष्मं फलं ततः ।
ऊनत्वे कल्पितहरस्याधिकं तत्फलं यतः ॥ ९३ ॥

फलबाहुल्यवशतो गुणेन हरणे स्फुटम् ।
गुणान्न्यूने तु गुणहारान्तरोऽल्पं क्रमात् फलम् ॥ ९४ ॥

यावदल्पं फलं संगृह्यात्यल्पं तदुपेक्ष्यते ।
हारान्न्यूनो गुणो यत्र हारार्धावधिकोऽपि सन् ॥ ९५ ॥

तत्रैवैवं फलानां तु क्रमादत्यल्पता भवेत् ।
हारार्धात्र गुणो न्यूनः क्वचिदप्यत्र सम्भवेत् ॥ ९६ ॥

गुणो व्यासार्धवर्गोऽसौ तद्भुजावर्गयुग् हरः ।
व्यासार्धावधिका कापि न भुजा स्याद्यतस्ततः ॥ ९७ ॥

गुणकारो हि विप्रेखावर्गस्तत्तच्छ्रुतेः कृतिः ।
हारः स्यादनयोः कोटीकर्णवर्गात्मता यतः ॥ ९८ ॥

यतो दोर्वर्ग एव स्याद् गुणहारान्तरस्त्विह ।
विप्रेखाग्रात् पुनस्तत्तत्कर्णाग्रान्तरमत्र दोः ॥ ९९ ॥

इष्टतत्पूर्वकर्णाग्रविवरं गुण्यमिष्यते ।
कर्णान्तरालोत्थपरिध्यंशस्येच्छाफलं भवेत् ॥ १०० ॥

खण्डाणुत्ववशात् सापि परिध्यंशोऽथवा भवेत् ।
एषां फलानां योगोऽतः परिध्यष्टांशसम्मितः[1] ॥ १०१ ॥

अष्टमांशो वृतेर्यस्माद् दिक्कोणान्तरसंश्रितः ।
कर्णाग्राणां तु विवरं यतस्तुल्यतया स्थितम् ॥ १०२ ॥

विवरं तत्त्वणुमितं रूपत्वेनात्र कल्प्यते ।
दिक्सूत्रात् क्रमवृद्धानां[2] कर्णानां ये भुजाः क्रमात् ॥ १०३ ॥

व्याख्या—1. C, सङ्गतः 2. C. वृत्तानां

एकाद्येकोत्तरत्वेन स्थिता दोःखण्डकास्तु ते ।[1]
अमीषां हृतयस्तस्माद् गुणहारभिदा क्रमात् ॥ १०४ ॥

[2]गुणा विक्सूत्रवर्गो यत् तत्तत्कर्णकृतिर्हरः[3] ।
ततस्तत्तद्भुजाखण्डं निहताद् भुजखण्डतः ॥ १०५ ॥

व्यासार्धहृत्या लब्धं यं तद्योगस्त्वादिमं फलम् ।
अतो दोर्वर्गयोगेन गुणिताद् भुजखण्डतः ॥ १०६ ॥

व्यासार्धहृत्या लब्धं यत् स्यात्तदान्यफलान्वयः ।
अनेन विधिनैवाद्यात् फलाल्लभ्यं द्वितीयकम् ॥ १०७ ॥

गुण्यमाद्यं[4] फलं त्वत्र गुणहारौ पुरोदितौ ।
नानारूपास्ततो गुण्या गुणाश्चातः पृथक् क्रमात् ॥ १०८ ॥

तत्तद्गुणात् स्वगुण्यघ्नात् तत्तद्धारैः पृथक् फलम् ।
गुण्यान्याद्यफलानीह न पृथक्साधितान्यतः ॥ १०९ ॥

नाद्याद् द्वितीयसिद्धिः स्यात् ततः प्रथमगुण्यतः ।
रूपात्मकादेवोक्तेन विधिनाविष्कृतेन यः[5] ॥ ११० ॥

फलयोगो द्वितीयोऽपि सिध्येत् तत्र तु हारयोः ।
संवर्गेण हरेद् गुण्याद्धताद् गुणवधेन यत् ॥ १११ ॥

लभ्यते[6] फल[7]योगो द्वितीयस्त्रैराशिकद्वयात् ।
तत्तत्कर्णाप्ततो दिक्सूत्रान्तरस्य कृतिर्गुणः ॥ ११२ ॥

आद्यत्रैराशिके तद्वद् द्वितीयेऽपि गुणः स च ।
व्यासार्धवर्गो हारः स्यादुभयत्रापि यत्ततः ॥ ११३ ॥

गुणद्वयाहतिहतात् प्राच्यगुण्याद् विभज्य यत् ।
लभ्यते हारघातेन तद् द्वितीयं फलं भवेत् ॥ ११४ ॥

व्याख्या—1. C. कास्ततः　　2. C. गुणषद्सूत्र
3. C. कर्णश्रुतिर्हरः　　4. C. गुणमाद्यं
5. B. सः for यः　　6. B. C. संलभ्यते
7. C. फले

गुणयोरिह तुल्यत्वाद् गुणवर्गो गुणो भवेत् ।
हारवर्गो हरश्च स्याद् रूपं सर्वत्र गुण्यते ॥ ११५ ॥

अतो दोर्वर्गवर्गेण हता दो:खण्डतः पुनः ।
व्यासार्धवर्गवर्गेण द्वितीयं लभ्यते फलम् ॥ ११६ ॥

समषट्घातदोर्निघ्नाद् दो:खण्डात्तु तृतीयकम् ।
व्यासार्धसमषट्घातहरणाल्लभ्यते फलम् ॥ ११७ ॥

[1]तुर्यादीनि फलान्येवमूर्ध्वोर्ध्वसमघाततः ।
गुणनाद् हरणाच्चापि लभ्यते तान्यतः क्रमात् ॥ ११८ ॥

दो:खण्ड आदिमो गुण्यो गुणः[2] स्यादिह सर्वतः ।
अथ तत्तत्फलानां यद्योगमानेतुमिष्यते ॥ ११९ ॥

तत्तद्गुणानामैक्यं तत्सर्वत्र त्विष्यते गुणः ।
तत्र तावत् फलैक्यानामादिमस्य तु साधने ॥ १२० ॥

दिक्सूत्रतत्तत्कर्णाग्रविवरत्वेन ये क्रमात् ।
एकाद्येकोत्तरमिता व्यासार्धावधिका भुजाः ॥ १२१ ॥

तेषां कृतियुतिघ्नात्तु दो:खण्डाद् रूपतुल्यतः ।
व्यासार्धकृत्या यल्लब्धं फलयोगस्स आदिमः ॥ १२२ ॥

अथोक्तदोष्णां वर्गेण योगेनापि च ताडितात् ।
व्यासार्धवर्गवर्गाप्तः स्याद् द्वितीयफलान्वितः ॥ १२३ ॥

षडादिसमघातोत्थगुणयोगैस्तथा हरैः ।
एवं साध्यास्तृतीयादिफलयोगा यथाक्रमम् ॥ १२४ ॥

[सङ्कलितम्]

अथैवमुदितानां तु गुणानामैक्यसिद्धये ।
मूलवर्गघनादीनां वक्ष्ये सङ्कलितं क्रमात् ॥ १२५ ॥

यद्यपीह समोत्थानां घातैरेव प्रयोजनम् ।
तथापि तत्क्रमप्राप्ता शेषसङ्कलनोच्यते ॥ १२६ ॥

व्याख्या—1. C. तुरीयादिफलान्येवं 2. B. गुण्यः

[मूलसङ्कलितम्]

प्रवक्ष्यते प्रथमतो मूलसङ्कलितं ततः ।
एकाद्येकोत्तरत्वेन स्थिताः संख्यास्तु याः क्रमात् ॥ १२७ ॥

तद्योगः सङ्कलितमित्युच्यतेऽन्यच्च तादृशम् ।
इहाद्यपङ्क्तौ रूपं स्याद् व्यासार्धमितमन्त्यतः ॥ १२८ ॥

द्वितीयादिषु चैकैकवृद्धया पङ्क्तिषु ते क्रमात् ।
व्यासार्धतुल्यसंख्याः स्युः पङ्क्तयो व्यासपङ्क्तिषु ॥ १२९ ॥

व्यासार्धतुल्याः संख्याः स्युर्यदि तर्हीह तत्कृतिः ।
भवेत् सङ्कलितं नैवमुपान्त्यन्यूनता यतः ॥ १३० ॥

एकाद्येकोत्तरत्वेन पूर्वपूर्वासु पङ्क्तिषु ।
सा न्यूनता स्थिता तस्मात्[1] सापि सङ्कलितं ततः ॥ १३१ ॥

रूपा दिप्रूपोत्तरतो रूपो नान्त्यपदावधि[2] ।
अवस्थितमिदं[3] न्यूनांशसङ्कलितमित्यतः ॥ १३२ ॥

पूर्वसङ्कलिताद् व्यासार्धेनैवोनमिदं परम् ।
द्विघ्नात् सङ्कलिताद् व्यासार्धेनोनास्तत्कृतिस्ततः ॥ १३३ ॥

सैकव्यासार्धगुणितं व्यासार्धं यत्ततो दलम् ।
एकाद्येकोत्तरमितभुजासङ्कलितं भवेत् ॥ १३४ ॥

अणुत्वार्थं भुजाभागे त्वणुच्छेदाहृते सति ।
अत्र रूपं त्वणुमितं कल्प्यं यस्मात्ततोऽणुयुक् ॥ १३५ ॥

यद्व्यासदलमन्यच्च केवलं यत्तयोर्हतिः ।
या स्यात् तद्दलमुक्तस्य मानं सङ्कलितस्य तु ॥ १३६ ॥

छेदवर्गोद्धृता सेष्टव्यासार्धकृतिरेव यत् ।
प्रायो व्यासार्धवर्गार्धमिदं सङ्कलितं ततः ॥ १३७ ॥

व्याख्या—1. C. तस्मिन् 2. C. पदावपि
3. C. प्रवस्थितमिव

क्षेत्राकारं तथा कल्प्यमणुत्ववशतोऽस्य तत् ।
यथा कर्णेन विच्छिन्ना वर्गक्षेत्रवलाकृतिः ॥ १३८ ॥

ततः सङ्कलितं त्वत्र वर्गार्धप्रमितं भवेत् ॥ १३९ ॥

[वर्गसङ्कलितम्]

अथैकाद्येकवृद्धानां वक्ष्ये सङ्कलितं कृतेः ।
एकाद्येकोत्तरमिताः क्रमाद् ये बाहवस्त्विह ॥ १४० ॥

स्वतुल्यघातात् प्रत्येकं तेषां वर्गात्मता यतः ।
यदि सर्वे भुजा व्यासार्धतुल्यास्तर्हि तद्गुणम् ॥ १४१ ॥

मूलसङ्कलितं वेद्यं वर्गसङ्कलितं त्विति ।
एक एव गुणो व्यासार्धतुल्यं त्विह नेतरे ॥ १४२ ॥

ते तु रूपादिरूपोत्तरत्वेनोनाः क्रमाद् गुणाः ।
ततो व्यासार्धगुणितान्मूलसङ्कलितात् त्यजेत् ॥ १४३ ॥

उपान्त्यादिभुजानेकादिघ्नांस्तत्कृतिसिद्धये ।
यदोपान्त्यभुजा व्यासार्धेन हन्येत तत्ततः ॥ १४४ ॥

रूपाधिकत्वाद् गुणके रूपघ्नोपान्तिमं त्यजेत् ।
तत्पूर्वतस्तथा त्याज्यं द्विघ्नात्मानं तथा हतात् ॥ १४५ ॥

तत्तद्भुजोनव्यासार्धहतांस्तत्तद्भुजांस्ततः ।
व्यासार्धगुणितात् स्वस्मात् त्यजेत् स्वकृतिसिद्धये ॥ १४६ ॥

ततोऽन्त्याद्युत्क्रमेणैकाद् व्येकोत्तरहता भुजाः ।
ये तद्युतिं सङ्कलिताद् व्यासार्धगुणितात् त्यजेत् ॥ १४७ ॥

एक आद्यद्वितीयादि[1]मूलवर्गादिकः परः ।
द्विधा सङ्कलितस्यास्य मार्ग आद्यं द्वयोः समम् ॥ १४८ ॥

[2]एकाद्येकोत्तराङ्कानां यथायोगैः[3] पदान्तिमैः[4] ।
आद्यं सङ्कलितं तस्मादथ वक्ष्ये द्वितीयकम् ॥ १४९ ॥

व्याख्या—1. B. प्राद्य तृतीयादि 2. A. एकाद्यैको
3. B. यदा योगैः 4. A. परान्तिमैः

उपान्त्यान्त्यैस्तथायोगैस्तादृगङ्कसमुत्थितैः ।
अधोऽधोऽधिकैश्चैवमादि चान्तैस्तथाविधैः ।। १५० ।।

तादृगङ्कसमुत्थैः स्युर्यानि सङ्कलितान्यपि ।
तेषां युतिर्द्वितीयं तूच्यते सङ्कलितं त्विह ।। १५१ ।।

कल्प्यं सङ्कलितं त्वन्त्यं या सर्वभुजसंयुतिः ।
अन्त्यहीनेतरेषां यो योगः स स्यादुपान्तिमः ।। १५२ ।।

उपान्त्यसङ्कलिततोऽप्याधस्थान्यपि चोक्तवत् ।
तत्तदन्तभुजायोगैर्नयेत् सङ्कलितान्यपि ।। १५३ ।।

अधोऽधोऽधिकैरङ्कैर्यथायोगैः पदान्ततः ।
नीतानि यानि तद्योगो द्वितीयाख्यं भवेदिदम् ।। १५४ ।।

इत्येवं सन्निवेशो यत्ततोऽन्त्यस्य भुजस्य तु ।
अनुप्रवेश एकस्मिन्नेव सङ्कलिते परम् ।। १५५ ।।

उपान्त्यस्य भुजस्यान्त्योपान्त्ययोः स्यात् समन्वयः ।
तथा तत्पूर्वपूर्वेषां क्रमात् त्रिचतुरादिषु ।। १५६ ।।

समन्वयः सङ्कलितेष्वपि यस्मात्ततः स्थितम् ।
एकाद्येकोत्तरैरङ्कैरन्त्याद् व्युत्क्रमतो[1] भुजाः ।। १५७ ।।

निहतास्तद्युतिः सङ्कलितैक्यं तद् भवेदिति ।
मूलसङ्कलिते व्यासार्धाहते योऽधिकांशकः ।। १५८ ।।

वर्गसङ्कलितात् सङ्कलितैक्येन समं स तु[2] ।
व्यासार्धकृत्यर्धमितं मूलसङ्कलितं मतम् ।। १५९ ।।

एकैकरहितव्यासार्धकृत्यर्धानि यानि च ।
तद्युतेः सम्मितं सङ्कलितैक्याख्यं यतस्ततः ।। १६० ।।

तदिदं वर्गवलसङ्कलितं भवति स्फुटम् ।
वर्गसङ्कलितार्धं वा मिथस्तौ द्वौ समौ यतः ।। १६१ ।।

व्याख्या — 1. B. रन्त्याद्युत्क्रमतो

2. A. adds ततः as an alternate reading for स तु ।

इह व्यासार्धगुणितं मूलसङ्कलितं तु यत् ।
वर्गसङ्कलितं सार्धसहितं तद् भवेत् ततः ॥ १६२ ॥

[1]स्वत्र्यंशे शोधितेऽस्मात्तद् वर्गसङ्कलितं भवेत् ।
यतो व्यासार्धवर्गार्धमूलसङ्कलितं मतम् ॥ १६३ ॥

स्वत्र्यंशे शोधिते तस्माद् घनत्र्यंशोऽवशिष्यते ।
अर्थात् त्र्यंशविशुद्धया यत् कृत्स्नः त्र्यंशोऽवशिष्यते ।
वर्गसङ्कलितं तस्माद् घनत्र्यंश इति स्थितम् ॥ १६४ ॥

[घनसङ्कलितम्]

तथा सङ्कलितैक्यं तु घनषष्ठांश इत्यपि ।
अथ व्यासार्धगुणिते वर्गसङ्कलिते कियत् ॥ १६५ ॥

घनसङ्कलितावाधिक्यमित्येतन्निरूप्यते ।
यदि कृत्स्नेऽपि दोर्वर्गे गुणे व्यासार्धमिष्यते ॥ १६६ ॥

उपान्त्याद् व्युत्क्रमादेकैकाधिक्यं स्याद् गुणे ततः ।
समूलेनैव हन्तव्या तत्तद्भुजकृतिर्युतः ॥ १६७ ॥

उपान्त्यात् पूर्वपूर्वेषां भुजानां कृतयः क्रमात् ।
एकाद्येकोत्तरहता यास्तद्योगोऽधिकांशकः ॥ १६८ ॥

वर्गसङ्कलितैक्यं स्यादेतत् पूर्वोक्तमार्गतः ।
अत एव घनत्र्यंशोद्भूतं सङ्कलितं त्विदम् ॥ १६९ ॥

घनसङ्कलितत्र्यंशं चैतद् योऽत्राधिकांशकः ।
वर्गसङ्कलिताद् व्यासार्धघ्नात् स्वचतुरंशके ॥ १७० ॥

त्यक्ते तु युक्तं घनसङ्कलितं शिष्टमित्यतः ।
वर्गवर्गत्रिभागात् स्वचतुरंशे विशोधिते ॥ १७१ ॥

शिष्यते[2] चतुरंशोऽत्र घनसङ्कलितं च तत् ।
तत्तदुत्तरमप्येवमेव सङ्कलितं भवेत् ॥ १७२ ॥

व्याख्या—1. A. Hapl. om. the two lines सत्र्यंशे etc.

2. A. om. शिष्यते

स्वपूर्वसमघातोत्थं यत्तत्सङ्कलितं कृतम् ।
तस्मिन् व्यासार्धनिहते भवेद्योऽत्राधिकांशकः ॥ १७३ ॥

पूर्वसङ्कलितैक्यं तदिति सिद्धं यतस्ततः ।
एकैकाधिकसंख्याप्तं यस्माल्लब्धं स्वतस्त्यजेत् ॥ १७४ ॥

शिष्टमूर्ध्वोर्ध्वसमघातोत्थं सङ्कलितं भवेत् ।
यत्संख्यया[1] विभक्तं यत् स्वच्छेदांशाधिकं यदि ॥ १७५ ॥

तर्हि स्वांशाद्व्यहारेण प्राग्विभक्ते फलं स्फुटम् ।
अर्धाधिक्येऽधिकस्य प्राक् त्रिसंख्याप्तं फलं यथा ॥ १७६ ॥

पदाद्येकोत्तराङ्कानां यावदिष्टं तु या हृतिः ।
एकाद्येकोत्तराङ्केषु तावताऽऽप्तं तु यत्फलम् ॥ १७७ ॥

तत्तु तत्पूर्वसमघातोत्थं सङ्कलितं भवेत् ।
एकोत्तरत्वस्याणुत्वात् सर्वं पदमिदं त्विह ॥ १७८ ॥

इति स्थितं सङ्कलितं मूलवर्गादिजन्मनाम् ।
एतेनैव द्वितीयादेश्चोपपत्तिर्विमृश्यताम् ॥ १७९ ॥

[द्वितीयादिसङ्कलितम्]

किन्त्वादिमं सङ्कलितमन्त्यं कल्प्यं द्वितीयके ।
साध्ये त्वधोऽधोऽवधिकैस्तादृशाङ्कसमुत्थितैः ॥ १८० ॥

यानि सङ्कलितान्येतान्युपान्त्यादीनि कल्पयेत् ।
एषां योगो द्वितीयाख्यं भवेत् सङ्कलितं त्विह ॥ १८१ ॥

इत्थं द्वितीयस्यान्त्यत्वात् कल्प्यं साध्ये तृतीयके ।
सर्वयोर्युतिराद्याख्यमन्त्यं कल्प्यं द्वितीयके ॥ १८२ ॥

अन्त्यहीनेतरयुतिर्यः स तूपान्तिमं यथा ।
तथा स्वान्त्यान्त्य[2]हीनेतरेषां योगैः परं [पदम्][3] ॥ १८३ ॥

व्याख्या—1. A. संख्यया

2. A. C. स्वान्तयाश्च ; B. स्वान्त्यान्त्य

3. A. B. C. read परम्

यावद्रूपावधि भवेदेतैर्योगो द्वितीयकम् ।
इत्युक्तः [1]सङ्कलितयोगोऽन्त्यसाध्ये तृतीयके ॥ १८४ ॥

तावत्कसङ्कलितैक्यैस्तदुपान्त्याद्यैस्तथायुतैः ।
तृतीयं स्यादिदं [सङ्कलितानां][2] गतिरीदृशी ॥ १८५ ॥

इहाद्यं पदवर्गार्धं वर्गसङ्कलिताद्दलम् ।
द्वितीयं घनषष्ठांशतुल्यं तत्प्रोक्तमार्गतः ॥ १८६ ॥

ततस्तृतीयं घनषष्ठांशसङ्कलितं भवेत् ।
चतुर्विंशांशतुल्यं तद्वर्गवर्गाद्यतस्ततः ॥ १८७ ॥

पदाद्येकोत्तराङ्कानां यावदिच्छं तु या हृतिः ।
एकाद्येकोत्तराङ्कानां हृता घातेन तावताम् ॥ १८८ ॥

भवन्त्यूर्ध्वोर्ध्वजातानि भूयः सङ्कलितान्यपि ।
अणुत्वार्थं पदे पूर्वमणुच्छेदाहृते सति ॥ १८९ ॥

छेदवर्गादिना पश्चाद् हर्तव्ये तेन ते उभे ।
कार्ये मार्गद्वयं सङ्कलितयोरित्थमीरितम् ॥ १९० ॥

[ज्या-चाप-व्यवहारः]

यस्मादत्र पुनर्वर्गाद्युत्थान्येव गुणाः क्रमात् ।
साध्यानि विषमात् घाताद्युक्तन्यायेन तान्यपि ॥ १९१ ॥

तानि त्रिपञ्चसंख्याद्यैर्हर्तव्यान्युक्तमार्गतः ।
तत्प्राप्ययुग्मसंख्यात्सम्मिताभ्यस्तपदं हरः ॥ १९२ ॥

हाराहृते गुणे तस्मिन् लभ्यते त्र्यादिभिर्हृतम् ।
एवमेव यतोऽन्त्यात्तच्छोध्यं स्यात् पूर्वपूर्वतः ॥ १९३ ॥

अन्ते व्यासार्धतः शुद्धे वृत्ताष्टांशं तु शिष्यते ।
सर्वाण्योजानि शोध्यानि क्षेप्यान्यन्यानि वा क्रमात् ॥ १९४ ॥

व्याख्या—1. A. C. इत्युक्ता ; B. इत्युक्त 2. A. B. C. read सङ्कलितं

3. C. सर्व for वर्ग

गुणहारान्तरहृताद् गुण्यात्तत्फलाच्च यत् ।
गुणेन यानि लभ्यानि गुण्ये क्षेप्यानि तान्यतः ॥ १९५ ॥

हाराद् गुणस्याधिकता यत्रात्रैष विधिर्मतः ।
न्यूने स्यात् कल्पितहरे फलाधिक्यं तु वास्तवात् ॥ १९६ ॥

यतोऽतोऽल्पहराप्तानां युग्मान्येव क्षिपेत् पृथक् ।
गुण्योऽस्तोऽन्यानि शोध्यानि प्रायः सूक्ष्मं भवेत् फलम् ॥ १९७ ॥

वास्तवेन हरेणाप्तं यथा लब्धं तथा स्फुटम् ।
फलबाहुल्यवशतो गुणेनाप्तेषु तु स्फुटम् ॥ १९८ ॥

गुणान्न्यूने तु गुणहारान्तरेऽल्पं क्रमात् फलम् ।
यावदर्धं गृहीत्वात्यल्पत्वात् शिष्टमुपेक्ष्यते ॥ १९९ ॥

हारान्न्यूनो गुणो यत्र हारार्धावधिकोऽपि सन् ।
तत्रैवं फलानां तु क्रमादत्यल्पता भवेत् ॥ २०० ॥

हारार्धान्न गुणो न्यूनः क्वचिदप्यत्र सम्भवेत् ।
गुणो व्यासार्धवर्गस्तत् तद्भुजावर्गयुग् हरः ॥ २०१ ॥

व्यासार्धावधिका कापि न भुजा स्याद् यतस्ततः ।
व्याद्योजसङ्ख्यालब्धानि व्यासार्धाद् यानि तानि तु ॥ २०२ ॥

फलानि कुर्याद् व्यासार्धे क्रमादृणधनं ततः ।
दिक्सूत्रकोणकर्णान्तरालोत्थः परिधिर्भवेत् ॥ २०३ ॥

असौ परिधिरष्टघ्नो वृत्तं स्यादथवा पुरः[1] ।
अष्टघ्नव्यासदलसम्मिताद् व्यासाच्चतुर्गुणात् ॥ २०४ ॥

व्याद्योजसङ्ख्यालब्धानि तत्रैवर्णधने कृते ।
चतुर्गुणव्यासमिते ततः स परिधिर्भवेत् ॥ २०५ ॥

[इष्टज्यायाः चापीकरणम्]

अथैतन्न्यायतो ज्यानां चापीकरणमुच्यते ।
इष्टज्यात्रिज्ययोर्घातात् कोट्याप्तं प्रथमं फलम् ॥ २०६ ॥

व्याख्या—1. B. C. पुरा

ज्यावर्गं गुणकं कृत्वा कोटिवर्गं च हारकम् ।
प्रथमादिफलेभ्योऽथ नेया फलततिर्मुहुः ॥ २०७ ॥

एकत्र्याद्योजसङ्ख्याभिर्भक्तेष्वेतेष्वनुक्रमात् ।
ओजानां संयुतेस्त्यक्ते युग्मयोगे धनुर्भवेत् ॥ २०८ ॥

दोःकोटयोरल्पमेवेष्टं कल्पनीयमिह स्मृतम् ।
मुहुःकृतेऽपि लब्धीनां नान्यथावसितिर्भवेत्[1] ॥ २०९ ॥

दिक्सूत्रादिष्टचापाग्रा या वृत्ते ज्यानुपाततः ।
चतुरश्रभुजायां सा बहिर्विपरिणम्यते ॥ २१० ॥

वर्गादिसङ्कलितत एतवीयात् पुरोक्तवत् ।
तत्सम्बन्धिपरिध्यंशो नेयश्चापतया फलैः ॥ २११ ॥

अथेत्थं राशिजीवातस्तत्परिध्यंशमानयेत् ।
व्यासवर्गाद् रविहतात् पदं स्यात् प्रथमं फलम् ॥ २१२ ॥

ततस्तत्तत्फलाच्चापि यावदिच्छं त्रिभिर्हरेत् ।
रूपाद्ययुग्मसंख्याभिर्लब्धेष्वेषु यथाक्रमम् ॥ २१३ ॥

विषमानां युतेस्त्यक्ते समयोगे वृतिर्भवेत् ।
राशिज्याव्यासतुर्योऽशस्तद्वर्गः षोडशांशकः ॥ २१४ ॥

चतुरश्रे परिणतः स तु तद्द्वादशांशकः ।
तन्मूलात् प्रोक्तमार्गेण द्वादशांशं वृतेर्नयेत् ॥ २१५ ॥

अथवार्ककृतिघ्नान्मूलतः कृत्स्नां वृतिं नयेत् ।
यतः कोटीकृते त्र्यंशो दोर्वर्गोऽन्तर्गतस्ततः ॥ २१६ ॥

आभ्यां[2] दोःकोटिवर्गाभ्यां गुणनाद् हरणान्मुहुः ।
प्रथमात्तत्फलततेर्भवेत् त्र्यंशपरम्परा ॥ २१७ ॥

ओजसङ्ख्याहृतिः सङ्कलितसिद्ध्यै पुरोक्तवत् ।
इत्थं स्वद्वादशांशत्वेनाऽऽनेया वा वृतिः स्फुटा ॥ २१८ ॥

व्याख्या—1. C. नान्यथावस्थितिर्भवेत् 2. C. om. आभ्यां

अथ बह्वोजसंख्याप्तिसिद्धस्य परिधेर्यथा ।
अन्त्यसंस्कारसिद्धेन समता स्यात् तथोच्यते ॥ २१९ ॥

विचार्यमाणो संस्कार एष सूक्ष्मो न वेत्यतः ।
तदर्थं परिधी नेयौ द्वौ पृथक् तौ समौ यदि ॥ २२० ॥

निरन्तराधऊर्ध्वस्थयुग्मसङ्ख्योत्थसंस्कृती ।
तर्हि सर्वत्र साम्यं सम्भवतीत्यवगम्यताम् ॥ २२१ ॥

अधस्थयुग्मसङ्ख्योत्थसंस्कारफलतुल्यता ।
यद्युत्तरोजयुग्मोत्थफलयोरन्तरस्य तु ॥ २२२ ॥

तदा साम्यं परिध्योः स्याद् यत्संस्कारफलं स्फुटम् ।
यया कयाचिद् विषमसङ्ख्यालब्धेन सम्मिता ॥ २२३ ॥

पूर्वोत्तरायुक्संख्योत्थसंस्कारफलयोर्युतिः ।
संस्कारोऽयं तथाऽऽनेतव्यः स्यात् तत्सूक्ष्मतेच्छुना[1] ॥ २२४ ॥

यद्युभावपि संस्कारहारौ द्विघ्नौजसम्मितौ ।
तर्हि तत्फलयोगोऽपि मध्यौजास्तेन सम्मितः ॥ २२५ ॥

सम्भवेन्न क्वचिदिदं यदि पूर्वफलं प्रति ।
द्विघ्नोत्तरोजसंख्या संस्कारहार इतीर्यते ॥ २२६ ॥

तद्वर्यूर्ध्वसंस्कारफलं प्रत्यप्येवं विधिर्भवेत् ।
ततो द्विघ्नौजसंख्योत्थं हारो भवितुमर्हति ॥ २२७ ॥

तदिदं पूर्वहारात् स्याच्चतुर्भिरधिकं यतः ।
अतो द्वयोश्च द्विघ्नोजसमता न क्वचिद्भवेत् ॥ २२८ ॥

यतो द्वया[2]न्तरितयोर्द्विघ्नयोः संख्ययोर्भिदा ।
चतुःसङ्ख्या भवेदन्योन्तियोर्यतयोरपि ॥ २२९ ॥

द्विघ्नोजसंख्यासन्नत्वसिद्ध्यै संस्कारहारयोः ।
द्व्यूनत्वं द्व्यधिकत्वं च विहितं क्रमतो यतः ॥ २३० ॥

व्याख्या—1. A. gives the alt. reading वेदिना

2. A. om. द्वया

मध्यौजसंख्यापेक्षातः समसंख्ये तथास्थिते ।
द्विघ्नोर्ध्वसमसंख्यातः प्रायो हारतया मतः ॥ २३१ ॥

अथेत्थं नीतसंस्कारफले स्थौल्यं कियद्भवेत् ।
इत्येतदवगन्तुं प्रागेषां सच्छेदतां नयेत् ॥ २३२ ॥

मध्यस्था विषमा संख्या या तल्लब्धं तु यत्फलम् ।
याऽधोर्ध्वयुग्मसंख्योत्थसंस्कारफलयोर्युतिः ॥ २३३ ॥

तयोरन्तरमानेतुमेषां सच्छेदतां नयेत् ।
अथैतेषां त्रयाणां तु संख्यावगमने सति ॥ २३४ ॥

समच्छेदत्वमानेतुं शाक्यं तत्कल्पने सति ।
साधारण्येन नीयेत संख्याया नेति शङ्क्यताम् ॥ २३५ ॥

धनर्णकल्पनाद् ज्ञात[1]संख्यान्यस्यासतोऽपि च ।
समच्छेदत्वमानेतुं शक्यमेव यतस्ततः ॥ २३६ ॥

अथ वक्ष्ये धनर्णाख्यं तत्संख्यापरिकल्पनम् ।
धनर्णभूतयो राश्योर्यो घातः स त्वृणं भवेत् ॥ २३७ ॥

धनयोर्ऋणयोर्वा यो घातः स तु धनं भवेत् ।
इति विंद्यां तथाऽज्ञातसंख्याराशेः पदस्थितिम् ॥ २३८ ॥

[अज्ञातादिसंख्यानां विन्यासवासना]

रूपाणां व्यक्तयो यावन्तः स्युरज्ञातसंख्यके ।
स्थानात् स्थानाधिरोहोऽत्र राशौ तावत्प्रमाणकः ॥ २३९ ॥

रूपस्थानं ततोऽत्राद्यं राशिस्थानं द्वितीयकम् ।
राशेर्वर्गघनादीनि स्थानानि स्युः पराण्यपि ॥ २४० ॥

विन्यासात् पूर्वरूपाणां रूपस्थानाख्यमादिमम् ।
राशिस्थव्यक्तिसंख्याभिरारोहात् स्याद् द्वितीयकम् ॥ २४१ ॥

व्याख्या—1. A. B. C. read कल्पनादज्ञात

राशिस्थानाभिधं तद्वत्तन्मितेरधिरोहणात् ।
राशिभी राशिवर्गाख्यं तृतीयं स्याद् यथा तथा ॥ २४२ ॥

चतुर्थं तु घनाख्यं स्याद्, वर्गवर्गाभिधं परम् ।
समपञ्चषघातानां स्थानान्यन्यान्यपि क्रमात् ॥ २४३ ॥

नैकं दशेति दशगुणोत्तरं स्थानकल्पनम् ।
राशिं प्रकल्प्य विषमां संख्यां न्यस्येविहोक्तवत् ॥ २४४ ॥

ततो राश्यात्मकं रूपं द्वितीये प्रथमे तु खम् ।
द्विगुणैर्यःसमाद्यून: पूर्वसंस्कारहारक: ॥ २४५ ॥

अतो द्विसंख्यं स्थानं द्वितयेऽप्याद्ये त्वृणाङ्कितम् ।
द्वितीयहारो द्व्यधिको यद् द्विकं स्थानयोस्तत: ॥ २४६ ॥

छेदा एते क्रमादेक एवांशो राशिषु त्रिषु ।
"अन्योन्यहाराभिहतौ हारांशा"विति मार्गत: ॥ २४७ ॥

स्वेतरच्छेदघातोंऽशच्छेदच्छेदत्रयाहृति: ।
दशाष्टाविंशतिद्वन्द्वघातच्छेदा: समास्तत: ॥ २४८ ॥

इत्थं नीते चतु:सङ्ख्यं स्याद् द्वितीयचतुर्थयो: ।
आद्ये स्थाने तु खं स्वर्णसाम्याच्छून्यं तृतीयके ॥ २४९ ॥

एषा समच्छेदमितिरांशास्तेषां पृथक् क्रमात् ।
ओजराश्याद्यकोष्ठे तु चतु:संख्यमृणाङ्कितम् ॥ २५० ॥

स्वर्णसाम्याद् द्वितीये खं चतु:संख्यं तृतीयके ।
अथ प्रथमहारांशस्याद्ये खं परयोर्द्विकम् ॥ २५१ ॥

भेदो द्वितीयहारांशे मध्यद्वयमृणं त्विति ।
यो येन यस्तृतीये स्याच्चतुष्कं पूर्वयोस्तु खम् ॥ २५२ ॥

अतो विषमसंख्यांशाच्चतु:संख्याधिकस्त्वयम् ।
संस्कारहारो द्विघ्नोर्ध्वसमसंख्येति कल्पते ॥ २५३ ॥

चतुर्घ्नेनौजसंख्याया विमूलेन घनेन यत् ।
लभ्यते षोडशहृताद् व्यासात् स्थौल्यमिदं भवेत् ॥ २५४ ॥

अभीष्टात् किञ्चिदधिकं संस्कारात्तं फलं ततः ।
यत एवं ततस्तत्परिहाराय हरद्वये ॥ २५५ ॥

रूपं क्षिप्त्वा समच्छेदं नीत्वा तत्स्थौल्यमानयेत् ।
हारत्रयवधात् पूर्वं नीत्वा सच्छेदता यतः ॥ २५६ ।

तदंशाः स्वेतरहरद्वयघातात्मकाश्च ये ।
ततो विषमसंख्यांशो घातः संस्कारहारयोः ॥ २५७ ॥

सरूपयोर्वधे यत्तदाधिक्यं हारयोर्युतिः ।
यत्स्वेतरस्वरूपेण हन्तव्याविति रेतरम् ॥ २५८ ॥

द्विघ्नौजसंख्यातुल्यत्वात् तयोर्योगश्चतुर्गुणः ।
ततो विषमसंख्यांशाधिक्यं स्यात् स्वचतुर्गुणम् ॥ २५९ ॥

पूर्वस्मादाद्यहारांशाधिक्यं विषमसम्मितम् ।
तद्वद् द्वितीये यत्स्वेतररूपघ्नौजतुल्यता ॥ २६० ॥

पूर्वस्मादधिकांशस्तद्योगे द्विघ्नौजसम्मितः ।
चतुर्गुणस्त्वोजराशौ द्विघ्नराशिभिदाऽनयोः ॥ २६१ ॥

राशिस्थानेऽपि च स्थौल्यमिदानीं प्राक् तदाविमे ।
पूर्णरूपं न योज्यं स्यात् संस्कारहरयोस्ततः ॥ २६२ ॥

अथ स्वभक्तरूपे तु युक्ते संस्कारहारयोः ।
प्राग्वत् सच्छेदतानीतिः पूर्वं स्थौल्यमिहानयेत् ॥ २६३ ॥

प्रागुक्तावोजसंख्यायां रूपद्वयमतोऽधिकम् ।
संस्कारहारयोर्द्विघ्नौजराश्यासन्नता[1] यतः ॥ २६४ ॥

संस्कारयोरंशयुतौ रूपाधिक्यं पुरोदितम् ।
पूर्णरूपयुतौ द्विघ्नराशितुल्यं यतोऽन्तरम् ॥ २६५ ॥

द्विघ्नराशिहृते तस्मिन् पूर्णरूपं ततोऽन्तरम् ।
यतः प्रागोजसंख्यायां न्यूनं रूपचतुष्टयम् ॥ २६६ ॥

इदानीं त्रिकमेवातः क्षेप्यं संस्कारहारयोः ।
स्वाप्तं रूपचतुष्कं स्यात् तत्प्रायःसूक्ष्मता भवेत् ॥ २६७ ॥

व्याख्या—1. A. B. C. actually read : द्विघ्नौजराश्यासन्नता

द्विघ्नौजसंख्या न्यूना च ह्यधिकौ च पुरोदितौ ।
संस्कारहारौ स्यासन्ने द्विघ्नयुक्संख्यके[1] इमे ॥ २६८ ॥

सच्छेदीकरणद्विघ्नयुक्संख्योत्था कृतिर्हरः ।
चतुस्संख्यान्वितांशोऽत्र द्विघ्नयुक्संख्यकोऽनयोः ॥ २६९ ॥

चतुस्संख्याभिरपवर्तनाद् युग्मार्धमंशकः ।
युग्मसंख्याकृतिः सैका च्छेदोऽप्यत्र यथोदितम् ॥ २७० ॥

[वृत्तपरिध्यानयनम्]

"व्यासे वारिधिनिहते रूपहृते[2] व्याससागराभिहते ।
त्रिशराद्विविषमसंख्याभक्तमृणं स्वं पृथक् क्रमात् कुर्यात् ॥ २७१ ॥

यत्संख्ययात्र हरणे कृते निवृत्ता हृतिस्तु जामितया ।
तस्या उर्ध्वगताया समसङ्ख्या तद्दलं गुणोऽन्ते स्यात् ॥ २७२ ॥

तद्वर्गो रूपयुतो हारो व्यासाब्धिघाततः प्राग्वत् ।
ताभ्यामाप्तं स्वमृणे कृते धने क्षेप एव करणीयः ॥ २७३ ॥

लब्धः परिधिः सूक्ष्मो बहुकृत्वो हरणतोऽतिसूक्ष्मः स्यात्" ॥ २७४ ॥

इति ।

[वृत्तपरिधौ सूक्ष्माः संस्काराः]

अथास्यापि कियत् स्थौल्यं संस्कारस्येति चिन्त्यते ।
संस्कारहारयोः स्वाप्तचतुष्कं क्षेप्यमत्र यत् ॥ २७५ ॥

"छेदघ्नरूपेषु लवा धनर्णमिति" मार्गतः । (लीलावती, ३४)
द्विघ्नौजसंख्या न्यूना च ह्यधिका च हरौ यतः ॥ २७६ ॥

ततो द्वाविंशतेर्वर्गौ चतुःसंख्यान्वितौ हरौ ।
द्वाविंशतिमितावंशौ तावता लब्धिनौ पुनः ॥ २७७ ॥

244 11
युगवेदाश्विनोर्भूमीन्दुसंख्यश्च हरांशकौ ।
1 4
आद्यसंस्का[रान्त]रे तु भूवेदौ स्तामृणाङ्कितौ ॥ २७८ ॥

व्याख्या—1. Mss. read संख्यते 2. हृत for हृते

10 1
दशसंख्यो हरो राशौ विषमे रूपमंशकः ।
"अन्योन्यहाराभिहतौ हरांशाविति" मार्गतः ॥ २७९ ॥

0-16-0
कोष्ठे पृथक् खनृपशून्यकोष्ठत्रितयागमाः ।
22-0-40
समच्छेदा अथाद्यांशा खवेद-ख-खराश्विनः ॥ २८० ॥

1 4 2
इत्थं द्वितीये कं त्वाद्ये वेदोऽन्यत्र करस्त्वृणम् ।
4 1
तद्युक्तौ[1] पञ्चमे वेदा कोष्ठेष्वन्येषु खं भवेत् ॥ २८१ ॥
16 4-0
ओजराश्यंशका भूपा कोष्ठत्रितयखागमाः ।
एतयोरन्तरं त्वाद्यकोष्ठे षोडशसंख्यकम् ॥ २८२ ॥

4 4
छेदेंऽशके च वेदाप्ते वेदोंशश्छेदकः पुनः ।
4—0 1—0
खवेदकोष्ठत्रितयशून्येन्दव इति क्रमात् ॥ २८३ ॥
अतो विषमसंख्यायाः समपञ्चहृतिर्यतः ।
चतुर्गुणेन मूलेन च्छेदोऽसौ निगमोंऽशकः ॥ २८४ ॥
स्थौल्यभूतमिदं, तत्र सैका युग्मकृतिर्हरः ।
तद्गुणो युग्मवर्गार्धमिति यत्रोदितं पुरा ॥ २८५ ॥
ततश्चतुर्गुणाद् हार्यात् प्रोक्तेन समनन्तरम् ।
छेदेन रूपाद्युत्येन भवेद् वृत्तं यथोदितम् ॥ २८६ ॥

[परिधिसूक्ष्मतायै प्रकारान्तराणि]

"समपञ्चा[हतयो या][2] रूपाद्ययुजां चतुःघ्नमूलयुताः ।
ताभिः षोडशगुणिताद् व्यासात् पृथगाहतेषु[3] विषमयुतेः ॥ २८७ ॥
समफलयोगे त्यक्ते स्यादिष्टव्याससम्भवः परिधिः" ॥ २८८ ॥

इति ।

व्याख्या—1. A. B. तद्युतौ 2. Mss. read हतायाया
3. A. पृथगाहृतेषु

"अथ केवलोजसंख्या द्विघ्ना संस्कारहार इति ।
कल्पनया यत् स्थौल्यं तत् परिहाराद् वृतिर्यथा[1] साध्या ॥ २८९ ॥
व्यासाद् वारिधिनिहतात् पृथगाप्तं त्र्याद्ययुग्विमूलघनैः ।
त्रिघ्नव्यासे स्वमृणं क्रमशः कृत्वापि परिधिरानेयः" ॥ २९० ॥

इति ।

"अथ यद्यन्तोजाप्तस्यार्धं संस्कार इति क्लृप्तिः ।
तत्स्थौल्यपरिहरणतोऽप्यावित एवं यथा भवेद् वृत्तम् ॥ २९१ ॥
द्व्यादियुजां[2] वा कृतयो व्येका हाराद् द्विनिघ्न[3]विष्कम्भे ।
धनमृणमन्तस्योर्ध्वगतोजकृतिर्द्विसहिता[4] हरस्यार्धम्" ॥ २९२ ॥

इति ।

"द्व्यादेश्चतुरादेर्वा चतुरधिकानां निरेकवर्गाश्चेत्[5] ।
हाराः कुञ्जरगुणिता विष्कम्भः स्वमतिकल्पितो भाज्यः ॥ २९३ ॥
फलयुतिरेकत्र वृतिर्भाज्यदलं फलविहीनमन्यत्र" ॥ २९४ ॥

इत्यादि ।

"एभ्यः सूक्ष्मतरोऽन्यो विलिख्यते कश्चनापि संस्कारः ।
अन्ते समसंख्यादलवर्गः सैको[6] गुणः स एव पुनः ॥ २९५ ॥
युगगुणितो रूपयुतः समसंख्यादलहतो भवेद् हारः ।
त्रिघ्नाद्विविषमसंख्याहरणात् परमेतदेव वा कार्यम्" ॥ २९६ ॥
इत्येवं महतो व्यासान्महान्तं परिधिं नयेत् ।
ततोऽल्पमनुपातेन नीत्वा पठतु तद्यथा ॥ २९७ ॥

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"वृत्तव्यासे हते नागवेदवह्न्यब्धिखेन्दुभिः ।
33215
तिथ्यश्विविबुधैर्भक्ते सुसूक्ष्मः परिधिर्भवेत् ॥ २९८ ॥
113 21600 355
त्रीशाङ्कमकलिप्ताभ्यो व्यासोऽर्थेष्वग्निभिर्हृतः ।
चक्रलिप्तादिपरिधिव्यासमाभ्यां नयेत् तथा" ॥ २९९ ॥

व्याख्या—1. A. B, C. read वृतियुथा 2. A. B. मध्यादियुजां
3. A. C. प्येकाकाराद्विनिघ्न 4. B. कृती द्वी सहिता
5. A. C. वर्गः स्यात् 6. A, B, C. read वर्गस्त्वेको

[शरचापज्यानयनम्]

वक्ष्येऽथ शरचापज्यानयनं बहुविस्तरम् ।
व्यासार्धरचिते वृत्ते विप्रेखाद्वितयाङ्किते ॥ ३०० ॥

विप्रेखापार्श्वयोः कल्प्यं समत्र्यश्रद्वयं ततः ।
व्यासार्धतुल्या कृत्स्नज्या चापासन्ना भुजा तयोः ॥ ३०१ ॥

वृत्तकेन्द्रात् तदग्रान्ता भुजाऽन्या तत्समा च भूः ।
व्यासस्यार्धेन येनेत्थं त्र्यश्रे भूमिः प्रकल्पिता ॥ ३०२ ॥

तदन्यार्धे न च भुवः कुर्यात् त्र्यश्रं तथापरम् ।
भुजाग्रद्वयसम्पातात् भूमध्यावधि लम्बितम् ॥ ३०३ ॥

सूत्रद्वयं तद्विवरमामूलाग्रं च भूसमः ।
भूमध्यपतितत्वेन लम्बयोरुभयोरपि ॥ ३०४ ॥

भूम्योरर्धद्वययुतेः कृत्स्नभूमिसमत्वतः ।
व्यासार्धतुल्या कृत्स्नज्या लम्बाग्रद्वितयं ततः ॥ ३०५ ॥

राशिद्वयसमस्तज्यास्तिस्त्रो वृत्तार्धसंश्रिताः ।
लम्बाग्रद्वितयस्पृष्टा समस्तज्या तु या भवेत् ॥ ३०६ ॥

तदर्धमेकराशिज्या तत्त्रिज्यावर्गभेदतः ।
मूलं राशिद्वयस्य ज्या तत्र ज्याविवरं शरः ॥ ३०७ ॥

राशेः समस्तज्याज्येष्वोर्वर्गयुक्तेः पदं ततः[1] ।
तदर्धमर्धराशिज्या तद्दोःकोटिशरैस्ततः ॥ ३०८ ॥

तत्तदर्धगुणाः साध्यास्तत्तद्दोःकोटिसायकैः ।
दोःकोट्योर्वर्गयोर्योगः कर्णवर्गसमो भवेत् ॥ ३०९ ॥

दोःकर्णवर्गविश्लेषः कोटिवर्गसमस्तथा ।
कर्णकोट्योर्वर्गभेदो भुजावर्गसमो यतः[2] ॥ ३१० ॥

दोस्तुल्यचतुरश्रं यत्कोटितुल्यचतुर्भुजः ।
क्षेत्रयोरनयोर्योगं कर्णतुल्यचतुर्भुजम् ॥ ३११ ॥

व्याख्या—1. B. om. ततः 1. C. मतः

[ज्याग्रहणं चापीकरणं च]

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लिप्ताभ्यस्तत्त्वनेत्राप्ता गता ज्याः, शेषतः पुनः ।

225

गतगम्यान्तरघ्नाच्च हृतास्तत्त्वयमैः क्षिपेत् ॥ २ ॥

दोःकोटिज्ये नयेदेवं ज्याभ्यश्चापं विपर्ययात् ॥ ३a ॥

तदर्थमिह दोस्तुल्यचतुर्बाहु तथापरम् ।
कोटि[1]तुल्यचतुर्बाहु सन्दध्यात् तद्द्वयं मिथः ॥ ३१२ ॥

यथाऽऽयामोऽत्र महतः स्वल्पाऽऽयामेन वर्धते ।
द्वयोरप्येकरेखास्थौ यथा स्यातां बहिर्भुजौ ॥ ३१३ ॥

अन्तःपार्श्वद्वये सक्ते महदल्पा च निस्सृतम् ।
कोणसन्धेर्महाक्षेत्रे तदन्तरमितावथ ॥ ३१४ ॥

खण्डयेत् प्रतिकोणान्तं बहिस्त्र्यश्रद्वयं यथा ।
रेखायोगात्तु ते त्र्यश्रे निष्कृष्य भ्रामयंस्तथा ॥ ३१५ ॥

व्यत्ययेन तु सन्दध्याद् रेखाभागौ बहिर्यथा ।
[2]प्राग् यद्रेखाग्रयोर्योगः पश्चादपि तयोस्तु सः ॥ ३१६ ॥

तथाकृतं च तत्क्षेत्रं कर्णतुल्यचतुर्भुजम् ।
अतो दोःकोटिकर्णेषु द्वाभ्यां तदितरोन्नयम् ॥ ३१७ ॥

तत्तच्चापाग्रतो दोर्ज्याः[3] प्राग्रेखाग्रास्ततोऽपराः ।
दक्षिणोत्तररेखाग्रां कर्णः केन्द्रान्तरं तत ॥ ३१८ ॥

[ज्याग्रहणं चापीकरणं च]

लिप्ताभ्य इति (II.2-3a)—

मन्दांशिनि फलं दृष्ट्वा यत्र स्वांशफलोन्नयः ।
फलप्रमाणदोर्ज्याप्त्या भाव्यं तत्रैककल्पया ॥ ३१९ ॥

व्याख्या—1. B. कोटी 2. C. प्राग्वत् for प्राग्
3. A. C. दोस्त्या:

[चापसन्धिगतार्धज्याः]

विलिप्तादशकोना ज्या राश्यष्टांशधनुःकलाः ॥ ३b ॥

223½

आद्यज्यार्धात् ततो भक्ते सार्धदेवाश्विभिस्ततः ।
त्यक्ते द्वितीयखण्डज्या द्वितीया ज्या च तद्युतिः ॥ ४ ॥
ततस्तेनैव हारेण लब्धं शोध्यं द्वितीयतः ।
खण्डात् तृतीयखण्डज्या[1] द्वितीयस्तद्युतो गुणः ॥ ५ ॥
तृतीयः स्यात् ततश्चैवं चतुर्थाद्याः क्रमाद् गुणाः ॥ ६a ॥

चापद्वयोस्त्रैराशिफलाद् विदितं[1] फलमंशयोः ।
अंशेष्वर्धादिषु फलस्योनाधिकतया स्थितेः ॥ ३२० ॥

ज्याखण्डाश्चापखण्डेषु युग्मौजपदयोः क्रमात् ।
उपर्युपरि वर्धन्ते क्षीयन्ते च समेष्वपि ॥ ३२१ ॥

एकस्मिश्चापखण्डेऽपि तद्वद् वृद्धिक्षयौ न किम् ।
नियमश्चापभागस्य यादृशः स्वार्धजीवया ॥ ३२२ ॥

तादृशो नियमो न स्याज्ज्याचापावयवेष्वपि ।
क्रमोत्क्रमाभ्यां सर्वत्र तद्वृद्धिक्षयदर्शनात् ॥ ३२३ ॥

यदि स्यादाद्यजीवेयं द्वितीयज्यावलं भवेत् ।
द्वितीयज्यापि सा नित्यं चतुर्थज्यावलं भवेत् ॥ ३२४ ॥

द्विगुणोर्ध्वोर्ध्वचापार्धरूपमिष्टधनुर्यतः ।
धनुषोरंशिमोर्ज्याप्तिस्ततोनांशेषु कल्प्यते ॥ ३२५ ॥

ज्याचापग्रहणे तस्मान्नोक्तं त्रैराशिकं स्फुटम् ॥ ३२६ ॥

मूलम्— 1. A. खण्डः स्यात् ; B. खण्डस्य

व्याख्या—1. A. C. विदिना ; B. द्विदिनं (wr.)

[चापसन्धिगतार्धज्याः]

विलिप्तादशकोनेति (II. 3b-15a)—

[पठितज्यानां सूक्ष्मतापादनम्]

आद्यचापाग्रमूलस्पृक्समस्तज्या तु या भवेत् ।
कर्णोऽसावाद्यचापाग्रस्फुटयोःकोटिखण्डयोः ॥ ३२७ ॥

व्यासार्धस्तद्धनुर्मध्यस्पृष्टं कर्णस्तथापरः ।
तद्दोःकोट्यो[1] धनुर्मध्यस्पृष्टे विष्कसूत्रयोर्द्वयात् ॥ ३२८ ॥

या चापभागकृत्स्नज्या कर्णस्तन्मध्यगोऽपि यः ।
तौ द्वौ समतिरश्चीनौ कृत्स्नज्यातच्छराविव ॥ ३२९ ॥

शरः कर्णैकदेशोऽत्र कृत्स्नज्या व्यस्तदिक् ततः ।
सूत्रात् पूर्वापरात् कर्णः स यावृग्वलितो भवेत् ॥ ३३० ॥

तावृगेव समस्तज्या स्वयाम्योत्तरसूत्रतः ।
अर्धचापज्यया कर्णो वलितः पूर्वसूत्रतः ॥ ३३१ ॥

धनुरग्रसमस्तज्यायोगात् प्राक्सूत्रगामिनः ।
मार्गतो वलितं कृत्स्नज्यान्यार्धं तद्वदेव हि ॥ ३३२ ॥

तदिच्छाफलमत्र स्यादाद्यचापशरोऽपि सः ।
चापखण्डसमस्तज्या तत्रेच्छाराशिरिष्यते ॥ ३३३ ॥

त्रिज्या तत्र प्रमाणं स्याच्चापार्धस्य फलं गुणः ।
यावता वलितं तूदक्सूत्राद् व्यासदलं[2] तु तत् ॥ ३३४ ॥

तावृक्समस्तज्यान्याग्रं वलितं पूर्वसूत्रतः ।
प्रमाणराशिर्व्यासार्धं फलं चापार्धकोटिका ॥ ३३५ ॥

कृत्स्नज्येच्छाथ चापाग्रात् पूर्वसूत्रावधिः फलम् ।
इत्थमाद्यधनुःखण्डज्याशरावनुपाततः ॥ ३३६ ॥

व्याख्या—1. A. कोट्या ; B. कोटी ; C. कोट्याः 2. Mss. व्यासं दलं

शरोनितं च व्यासार्धं कोटिज्या परिकल्प्यते ।
आद्यद्वितीयचापार्धयोगश्चापं[1] यदा भवेत् ॥ ३३७ ॥

तच्चापाग्रद्वयस्पृष्टा कृत्स्नज्या च भवेत्तदा ।
केन्द्रतोऽप्याद्यचापान्तावधिः कर्णश्च कीर्तितः ॥ ३३८ ॥

तत्प्रमाणमिहाद्यज्या तत्कोटचौ तत्फले उभे ।
इच्छाराशिः समस्तज्या[2] तदग्रोद्गतरेखयोः ॥ ३३९ ॥

सम्पाततः समस्तज्याप्रान्तरे[3] तत्फले उभे ।
इच्छाफले प्रागपरे फलं याम्योत्तरं परम् ॥ ३४० ॥

प्रमाणस्य फले पूर्वापरे याम्योत्तरं परम् ।
दोःकोटिखण्डौ स्यातां ते कृत्स्नज्यायाः श्रुतेः[4] फले ॥ ३४१ ॥

तत्राद्यचापमध्योत्था दोर्ज्या बाहुफलान्विता[5] ।
तत्कोटिफलहीनाद्यचापार्धाश्रित[6]कोटिका ॥ ३४२ ॥

द्वितीयचापमध्योत्थे दोःकोटिज्ये उभे क्रमात् ।
चापमध्योत्थदोःकोटिज्याभ्यां तत्सन्धिसंश्रितौ ॥ ३४३ ॥

कोटिदोःखण्डकौ सन्धिस्थाभ्यां तन्मध्यसंश्रितौ ।
स्वपूर्वचापसन्ध्युत्थदोर्ज्यायां दोःफलं क्षिपेत् ॥ ३४४ ॥

स्वपूर्वचापसन्ध्युत्थ[7]कोट्योः कोटिफलं त्यजेत् ।
तदेष्टचापसन्ध्युत्थदोःकोटिज्ये क्रमान्मते ॥ ३४५ ॥

स्वपूर्वचापमध्योत्थदोःकोट्योरेवमेव च ।
क्षेप्यं शोध्यं च तन्मध्यजीवाप्त्यै[8] तत्फलद्वयम् ॥ ३४६ ॥

व्याख्या—1. A. योगच्चापं ; B. योगाश्चापं

2. A. समस्ते ज्या ; C. om. इच्छाराशिः समस्तज्या

3. A. समस्ते ज्यान्तरे

4. C. श्रुतौ

5. A. फलान्वितात्

6. C. चापार्धाहृत

7. C. सन्ध्योत्थ

8. C. जीवाप्ते(:)

[अर्धज्यानयने प्रकारान्तरम्]

व्यासार्धं प्रथमं नीत्वा ततो वान्यान् गुणान् नयेत् ॥ ६b ॥

113 21600 355
त्रीशघ्नचक्रलिप्ताभ्यो व्यासोऽर्थेष्वग्निभिर्हृतः ।
तद्दलाद्यज्ययोः कृत्योर्भेदान्मूलमुपान्तिमा ॥ ७ ॥

अन्त्योपान्त्यान्तरं द्विघ्नं गुणो व्यासदलं हरः ।
आद्यज्यायास्[1]तथापि स्यात् खण्डज्यान्तरमादितः ॥ ८ ॥

ताभ्यां तु गुणाहाराभ्यां द्वितीयादेरपि क्रमात् ।
उत्तरोत्तरखण्डज्याभेदाः पिण्डगुणार्धतः ॥ ९ ॥

एवं सावयवा जीवाः सम्यङ् नीत्वा पठेत् क्रमात् ॥ १०a ॥

एवं स्वचापमध्योत्थज्याभिश्चापाग्रगामिनीः ।
जीवाः संसाधयेत् कृत्स्नाः पादान्तावधिसंस्थिताः ॥ ३४७ ॥

[ज्याखण्ड-खण्डान्तराणि]

इच्छाप्रमाणयोस्तत्र कृत्स्नज्यात्रिभजीवयोः ।
नियतत्वादनियमात् प्रमाणोत्थफलस्य च ॥ ३४८ ॥

गुणकारान्तरेणैव भवेदिच्छाफलान्तरम् ।
अतोऽत्र चापमध्योत्थकोटिज्याविवरेण तु ॥ ३४९ ॥

गुणभाच्चापसन्ध्युत्थयोर्ज्याखण्डान्तरं भवेत् ।
चापमध्योत्थयोःखण्डगुणनाच्चापसन्धिगम् ॥ ३५० ॥

कोटिखण्डान्तरं ज्ञेयमिति खण्डान्तरं मिथः ।
तत्राद्यचापसन्ध्युत्थां वोर्ज्यां कृत्स्नगुणाहताम् ॥ ३५१ ॥

त्रिज्यया विभजेत् कोटीखण्डस्तच्चापमध्यगः ।
तं समस्तज्यया हत्वा त्रिज्यया विभजेत् पुनः ॥ ३५२ ॥

मूलम्— 1. C. आद्यज्यातः

आद्यद्वितीयसन्ध्युत्थयोर्ज्याखण्डान्तरं भवेत् ।
तस्मादाद्यगुणं कृत्स्नज्यावर्गनिहतं हरेत्[1] ॥ ३५३ ॥

त्रिज्यावर्गोद्धृतं खण्डान्तरमाद्यद्वितीययोः ।
एवं समस्तज्यावर्गघ्नान्ततत्पिण्डमौर्विकाम् ॥ ३५४ ॥

त्रिज्यावर्गेण विभजेत् तत्तत्खण्डान्तरं यतः ।
कृत्स्नज्यात्रिज्ययोर्यादृङ्नियमो वर्गयोर्भवेत् ॥ ३५५ ॥

पिण्डज्यानां च तत्पार्श्वखण्डयोर्विवरस्य च ।
तादृशो नियमो देश्यो येन त्रैराशिकं स्फुटम् ॥ ३५६ ॥

आद्यचापगुणात् कृत्स्नज्यावर्गाद्याद्यमुद्धृतम् ।
खण्डयोर्विवरत्रिज्यावर्गेणाद्यद्वितीययोः ॥ ३५७ ॥

द्वितीयगुणतस्तद्वत् स्याद् द्वितीयतृतीययोः ।
एवं तत्तद्गुणात् कृत्स्नज्यावर्गेण समाहतात् ॥ ३५८ ॥

त्रिज्यावर्गोद्धृतं तद्वत् तदूर्ध्वखण्डान्तरं भवेत् ।
कल्पितेऽत्र गुणे रूपे हारः कल्प्योऽनुपाततः ॥ ३५९ ॥

सार्धदेवाश्विक[2]प्रायो प्लाविका[3]द्वितयाधिकः ।
हारो, गुणस्तु द्विघ्नान्त्योपान्त्यज्याविवरं भवेत् ॥ ३६० ॥

[ज्याखण्डान्तरयोगः]

खण्डान्तराणि यावन्ति ह्याद्यात्प्रभृति तावताम् ।
योगे त्यक्ते त्वाद्यखण्डाविष्टखण्डः स लभ्यते ॥ ३६१ ॥

खण्डान्तराणां युगपद्ग्रहणं यदि वाञ्छितम् ।
ज्यायोगतस्ता कृत्स्नज्यावर्गेण च समाहतात् ॥ ३६२ ॥

त्रिज्यावर्गोद्धृतं खण्डान्तरयोगो भवेत् ततः ।
स्वचापभागमध्योत्थकोटीखण्डयुतेरपि ॥ ३६३ ॥

खण्डान्तरयुतिः कृत्स्नज्याघ्न्या[4] त्रिज्याहृताऽथवा ।
चापसन्ध्युत्थपिण्डज्यायोगात् कृत्स्नज्यया हतात् ॥ ३६४ ॥

व्याख्या—1. B. भवेत् for हरेत् 2. B. देवाश्वितः
3. प्लाविका (?)=विलिप्तिका 4. Mss, ज्याघ्ना;

त्रिज्याप्ता चापमध्योत्थकोटीखण्डयुतिर्भवेत् ।
आद्यज्यातोऽन्त्यजीवान्तो ज्यानां योगः कृतो यथा[1] ॥ ३६५ ॥

कृत्स्नज्या सा[2] त्रिजीवाप्ता कोटीखण्डयुतिस्ततः ।
आद्यज्यातोऽप्युपान्त्यान्तो ज्यायोगो यस्तथापरः ॥ ३६६ ॥

तेनाद्योपान्त्यखण्डद्वयोर्वृभूतं विवरं भवेत् ।
तस्माद्व्युत्क्रमतोऽधोऽधो ज्यायोगा बहवोऽत्र ये ॥ ३६७ ॥

आद्यद्वितीययोगान्ताः कर्तव्यास्ते निरन्तरम् ।
योगात् तेषां[3] समस्तानां कृत्स्नज्यावर्गताडितात् ॥ ३६८ ॥

त्रिज्यावर्गेण विहृतं यज्ज्यायोगोत्थितं फलम् ।
शरखण्डयुतेः कृत्स्नज्याघ्न्यास्त्रिज्याप्तसम्मितम् ॥ ३६९ ॥

अभीष्टचापे यावन्तः खण्डाः स्युः परिकल्पिताः ।
तत्खण्डसंख्यागुणितादाद्यखण्डात् त्यजेच्च तत् ॥ ३७० ॥

सा स्यादिष्टधनुर्जीवाखण्डज्यायोगरूपिणी ॥ ३७१ ॥

[ज्याखण्डान्तरसङ्कलितम्]

यावता चापखण्डानां पिण्डज्या पठितात्र सा ।
[4]तदूर्ध्वचापखण्डानां खण्डज्यान्तरसाधनम् ॥ ३७२ ॥

यावतां चापखण्डानां पिण्डज्यासंयुतिस्तथा ।
तदूर्ध्वचापखण्डस्य खण्डज्याविवरं भवेत् ॥ ३७३ ॥

पिण्डज्याचापसंख्यायास्तत एकाधिका भवेत् ।
तत्रेष्टचापसंख्या स्याद् यया़त्र गुणनोदिता ॥ ३७४ ॥

चापभागसमाहृ[5]त्याद्याद्यज्याखण्ड इष्यते ।
स खण्डसंख्यागुणित इष्टचापधनुर्मितः ॥ ३७५ ॥

व्याख्या—1. B. कृतोऽत्र यः
2. B. ज्याघ्ना ; C. ज्याना
3. A. योगस्तेषां
4. Mss. read तमूर्ध्वं
5. B. समो for समा

[इष्टप्रवेशे सूक्ष्मज्याः]

इष्टदोःकोटिधनुषोः स्वसमीपसमीरिते ॥ १०b ॥

ज्ये द्वे सावयवे न्यस्य कुर्यादूनाधिकं धनुः ।

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द्विघ्नतल्लिप्तिकाप्तैकशरशैलशिखीन्दवः ॥ ११ ॥

न्यस्यात् छेदाय च मिथस्तत्संस्कारविधित्सया ।

छित्वैकां प्राक् क्षिपेज्जह्यात् तद्धनुष्यधिकोनके ॥ १२ ॥

अन्यस्यामथ तां द्विघ्नां तथाऽस्यामिति संस्कृतिः ।

इति ते कृतसंस्कारे[1] स्वगुणौ धनुषोस्तयोः ॥ १३ ॥

तत्राल्पीयः कृतिं त्यक्त्वा पदं त्रिज्याकृतेः परः[2] ॥ १४a ॥

[इष्टज्यायाः माधवोक्तं चापीकरणम्]

ज्ययोरासन्नयोर्भेदभक्तस्तत्कोटियोगतः ॥ १४b ॥

छेदस्तेन हृता द्विघ्ना त्रिज्या तद्धनुरन्तरम् ॥ १५a ॥

फलमुक्तवदानीतमिष्टचापात् ततस्त्यजेत् ।

इष्टज्या शिष्यते तत्र वक्ष्यमाणविधेः स्फुटा ॥ ३७६ ॥

आद्यात् तदिष्टचापान्तं ततः खण्डान्तराणि तु ।

एकाद्येकोत्तरं तेषां यत्तु सङ्कलितं भवेत् ॥ ३७७ ॥

तत्तुल्यमिष्टज्याचापविवरं परिकल्प्यते ॥ ३७८ ॥

[पठिताज्याभिर्विना इष्टज्याशरानयनम्]

तत्र ज्यानामविज्ञानाच्चापसङ्कलितं तु यत् ।

ज्यायोगः कल्प्यते तत्र त्वन्त्यज्येष्टधनुर्भवेत् ॥ ३७९ ॥

एकद्व्यादिधनुर्भागहीनास्तूपान्त्यतोऽपि ते ।

स्वल्पत्वात्ते धनुर्भागा रूपत्वेन प्रकल्पिताः ॥ ३८० ॥

मूलम्—1. A. B. संस्काराः 2. A. परम्

इष्टचापे तु या रूपव्यक्तयस्तत्समास्ततः ।
एकाद्येकोत्तराङ्कानां योगाज्ज्यायोग इष्यते ॥ ३८१ ॥

स चापयोगकृत्स्नज्याहतो व्यासदलोद्धृतः ।
लब्धा तच्चापमध्योत्थकोटीखण्डयुतिर्भवेत् ॥ ३८२ ॥

सन्ध्युत्थकोटिखण्डानां योगस्तत्र शरो भवेत् ।
कोटिखण्डयुतिर्यात्र चापमध्यगतोदिता ॥ ३८३ ॥

चापसन्ध्युद्भवस्थाभ्यां कोटीखण्डयुतिः शरः ।
तौ प्रायेण समौ चापखण्डस्याणुत्वकल्पनात् ॥ ३८४ ॥

अणुत्वाच्चापभागानां रूपत्वेन प्रकल्पनात् ।
समस्तज्यापि तत्तुल्या या न भेदकरी गुणे ॥ ३८५ ॥

एकाद्येकोत्तराङ्कानां यावदिच्छं तु या हृतिः ।
एकाद्येकोत्तराङ्कानां हृता घातेन तावताम्[1] ॥ ३८६ ॥

भवन्त्यूर्ध्वोर्ध्वजातानि तेषां सङ्कलितान्यतः ।
अणुत्वार्थं धनुर्भागे त्वणुच्छेदाहते सति ॥ ३८७ ॥

एवं प्रकल्प्य सैकेन पदेन गुणयेदमुम् ।
छेदवर्गोद्धृतस्त्विष्टचापवर्गो भवेदसौ ॥ ३८८ ॥

चापवर्गस्य तस्यार्धं चापसङ्कलितं भवेत् ।
पदसैकपदाभ्यासार्धस्य सङ्कलितत्वतः ॥ ३८९ ॥

धनतद्वर्गवर्गाभ्यामभीष्टधनुषस्ततः ।
एकाद्येकोत्तराङ्कानां संवर्गेण समुद्धृतात् ॥ ३९० ॥

भवन्त्यूर्ध्वोर्ध्वजातानि भूयः सङ्कलितानि ह ।
ततोऽत्र चापभागानामाद्यं सङ्कलितं तु यत् ॥ ३९१ ॥

आद्यज्याभीष्टचापान्तं ज्यायोगः सम्प्रकल्प्यते ।
ज्यायोगः स तु कृत्स्नज्याभिहतस्त्रिज्ययोद्धृतः ॥ ३९२ ॥

व्याख्या—1. A. C. तावता

इष्टः शरो द्वितीयस्मादथ सङ्कलितात्तु यो ।
[1]ज्यायोगानां सङ्कलितं लभ्यतेऽथ ततोऽपि च ॥ ३९३ ॥

कृत्स्नज्यावर्गनिहृता त्रिज्यावर्गेण चोद्धृतम् ।
ज्याचापविवरं तत्र कृत्स्नज्याल्पसम्मिता ॥ ३९४ ॥

अतो न गुण्यते तेन केवलं हरणं मतम् ।
केवलाच्छरतस्तस्माद् व्यासार्धेन हृतं फलम् ॥ ३९५ ॥

आद्यान्त्य[2]खण्डविवरं स्वज्यायोगसमुत्थितम् ।
एकाद्येकोत्तराङ्कानां यथायोगैः पदान्तिमैः ॥ ३९६ ॥

आद्यान्त्यखण्डान्तरं यथोक्तमार्गेण साधितम् ।
[3]उपान्त्याद्यैस्तथा योगैस्तादृगङ्कसमुत्थितैः ॥ ३९७ ॥

तथाद्योपान्त्यखण्डज्यान्तरमानीयतां बुधैः ।
आद्यद्वितीयखण्डान्तरान्तमेवमधोगतम् ॥ ३९८ ॥

कृत्स्नं खण्डान्तरं नेयं ज्यायोगैस्तदधोगतैः ।
एकाद्येकोत्तरैरङ्कैश्चापतुल्यपदस्थितैः ॥ ३९९ ॥

यत्तु सङ्कलिताञ्नीतं[4] ज्यायोगः स तु कल्प्यते ।
तस्माद्विष्टशरः कार्यो यच्चोपान्त्यादिसंश्रितैः ॥ ४०० ॥

तेषां सङ्कलितैक्यज्या[5] योगसङ्कलितं भवेत् ।
ज्यायोगसङ्कलितस्त्विष्टज्याधनुरन्तरम् ॥ ४०१ ॥

इष्टचापस्य वर्गः स्याद् व्यासार्धाप्तस्ततः शरः ।
ततो व्यासार्धवर्गेण स्वेष्टचापघनात्तु यत् ॥ ४०२ ॥

ततः षड्भिर्हृतं चापज्यान्तरं प्रायशो मतम् ।
यस्माल्लब्धः शरस्तस्मादेव सङ्कलितात् पुनः ॥ ४०३ ॥

व्याख्या—1. B. This line is transposed two lines above, *i. e.*, before ज्यायोग: etc., 392b.

2. A. आद्यान्त 3. A. उपान्त्यान्तैस्तथा

4. Mss. सङ्कलितन्नीतं 5. A. तैस्त्याज्या

इष्टचापहृता त्रिज्याकृत्या भक्तं त्रिभिर्हरेत् ।
शराद्वाभीष्टचापघ्नाद् व्यासार्धाप्तं त्रिभिर्हरेत् ॥ ४०४ ॥

ज्याचापान्तरमित्थं वाऽऽनीतं स्वधनुषस्त्यजेत् ।
इष्टज्या स्यादभीष्टज्या तच्छरौ प्रायिकौ नयेत् ॥ ४०५ ॥

चापसङ्कलितोत्थत्वादत्र स्थौल्यमपोहितुम् ।
एवमेव ह्युपान्त्यादेर्ज्याचापान्तरमानयेत् ॥ ४०६ ॥

तत्तच्चापात्त्यजेत्तत्तु तत्तज्जीवा भवन्त्यतः ।
ज्याचापान्तरयोगं वा चापयोगात् त्यजेत्ततः[1] ॥ ४०७ ॥

ज्यायोगः स्यात्ततः प्राग्वच्छरखण्डयुतिं नयेत् ।
यावक् सङ्कलिताल्लब्धं ज्याचापान्तरमन्तिमम् ॥ ४०८ ॥

तावगेव ह्युपान्त्यादिज्याचापान्तरसाधनम् ।
किन्त्वेकद्व्यादिरहितं तेषामन्त्यपदात् पदम् ॥ ४०९ ॥

ततः सङ्कलितावन्त्यज्याचापान्तरसाधनात् ।
ततोऽप्यूर्ध्वस्थितं सङ्कलितं तद्योगसाधनम् ॥ ४१० ॥

तस्मादिष्टधनुर्वर्गवर्गात् सङ्कलितं तु यत् ।
एकाद्येकोत्तराङ्कानां चतुर्णां घातसंहृतात् ॥ ४११ ॥

हृत्वा व्यासार्धवर्गेण ज्याचापान्तरसंयुतिः ।
तां चापयुतितस्त्यक्त्वा ज्याचापान्तरसंयुतिः ॥ ४१२ ॥

ज्यायोगः स्यात् ततो व्यासार्धोद्धृतस्तु शरो भवेत् ।
ज्याचापान्तरयोगाद्वा व्यासार्धेनोद्धृतं फलम् ॥ ४१३ ॥

चापयोगोत्थितशरात् त्यक्तेऽस्मिन् सुस्फुटः शरः ।
यतो ज्यायोगतो व्यासार्धोद्धृतस्तु शरो भवेत् ॥ ४१४ ॥

ततो व्यासार्धकृत्याद्यान्त्यखण्डान्तरमुद्धृतम् ।
तस्मादाद्योपान्त्यखण्डान्तरादारभ्य तत्क्रमात् ॥ ४१५ ॥

आद्यद्वितीयखण्डान्तरान्तसङ्कलितानि च ।
यानि तद्योगतो नेयं चापज्याविवरं ततः ॥ ४१६ ॥

व्याख्या—1. B. त्तुतः; C. त्तुतां

शरस्य साधनत्वेन यत्तु सङ्कलितं मतम् ।
तदूर्ध्वसङ्कलिततो ज्याचापान्तरमिष्यते ॥ ४१७ ॥

ततोऽत्राभीष्टचापस्य घनवर्गसमाहृतेः ।
एकाद्येकोत्तराङ्कानां पञ्चानां या समाहृतिः ॥ ४१८ ॥

तया विभक्तं व्यासार्धं वर्गवर्गेण चोद्धृतम् ।
ज्याचापान्तरमेवं तु नीतं स्फुटतरं भवेत् ॥ ४१९ ॥

द्वितीयशरतस्तस्माच्चापघ्नात् पञ्चभिर्हृतम् ।
हरेद् व्यासार्धवर्गेण यद्वा ज्याधनुरन्तरम् ॥ ४२० ॥

शरशोध्यांशतो चेष्टचापघ्नात् त्रिज्ययोद्धृतम् ।
ज्याचापान्तरतः शोध्यं पूर्वानीतात् स्फुटं तु तत् ॥ ४२१ ॥

एवं कृतासावन्त्यज्या सूक्ष्मा प्रायेण कल्प्यते ।
उपान्त्याद्याश्च जीवास्तदेवमर्हन्ति सूक्ष्मताम् ॥ ४२२ ॥

यतः सङ्कलितात् सूक्ष्मं ज्याचापविवरं कृतम् ।
तदूर्ध्वसङ्कलिततो ज्याचापान्तरसंयुतिः ॥ ४२३ ॥

ज्यायोगश्च शरश्चापज्यान्तरं तु तदूर्ध्वतः ।
तदूर्ध्वसङ्कलिततोऽप्येवं कार्यं[1] मुहुर्मुहुः ॥ ४२४ ॥

कार्ये फलान्तरे लब्धं स्वपूर्वफलतस्त्यजेत् ।
राशिरिष्टधनुस्त्वाद्यस्तस्माच्चापहतादपि ॥ ४२५ ॥

त्रिज्याभक्तोर्धितश्चापि द्वितीयो राशिरिष्यते ।
ततश्चापेन निहतात् त्रिज्ययाप्तं त्रिभिर्हरेत् ॥ ४२६ ॥

राशिस्तृतीयस्तस्मात्तु चापघ्नात् त्रिज्ययोद्धृतम् ।
चतुर्भक्तश्चतुर्थः स्यात् ततश्चापहतादपि ॥ ४२७ ॥

त्रिज्यया पञ्चभिश्चापि विहृतः पञ्चमो भवेत् ।
एवं स्वपूर्वराशेस्तु चापघ्नात् त्रिज्ययोद्धृतम् ॥ ४२८ ॥

व्याख्या—1. C. कुर्यात्

तद्रूर्ध्वसंख्याविहृतो भवेद्राशिस्तदूर्ध्वग:[1] ।
शोध्या: क्षेप्या: क्रमाद्याद्यास्तृतीयाद्योजराशय: ॥ ४२९ ॥

द्वितीयतश्चतुर्थाद्या: शोध्या: क्षेप्यास्तथा क्रमात् ।
ज्याशराविष्टचापस्य सुसूक्ष्मौ भवतस्तत: ॥ ४३० ॥

यावत्कृतोऽत्र चापेन गुणना परिकल्प्यते ।
व्यासार्धेनापि हरणं तावत्कृत्वो विधीयते ॥ ४३१ ॥

एकाद्येकोत्तरैश्चाङ्कैरूर्ध्वसङ्कलितेच्छया ।
चक्रपादकलातुल्ये त्विष्टे धनुषि कल्पिते ॥ ४३२ ॥

कर्तव्यौ ज्याशरावित्थं व्यासार्धप्रमितौ च तौ ।
व्यासार्धं वृत्तपादश्च तत्र वृत्तान्तरोद्भवौ ॥ ४३३ ॥

चक्रपादकलात्माद्यो द्वितीय: स द्विभाजित: ।
सुसूक्ष्मपरिहारार्धतद्विष्कम्भहृता हृत: ॥ ४३४ ॥

सोऽथ त्रिभिर्हृतस्तद्वत् तृतीयो भविता तत:[2] ।
चतुराद्यैश्चतुर्थाद्या भवन्तीष्टा यथाक्रमम् ॥ ४३५ ॥

क्रमोत्क्रमज्ये तद्वृन्दसंस्काराच्च क्रमान्मुहु: ।
यैरोजयुग्मैर्निर्मातुं शक्यास्ते राशयो ह्यमी ॥ ४३६ ॥

[इष्टज्याशरानयनोपयोगीनि माधवोदितानि
'विद्वान्' इत्यादिवाक्यानि]

0′-0″-44‴ 0′-33″-6‴ 16′-5″-41‴ 273′-57″-47‴
'विद्वांस्', 'तुन्नबल:', 'कवीशनिचय:', 'सर्वार्थशीलस्थिरो'
2220′-39″-40‴
'निर्विद्धाङ्गनरेन्द्ररुङ्' निगदितेष्वेषु क्रमात् पञ्चसु ।
आधस्त्याद् गुणितादभीष्टधनुष: कृत्या विहृत्यान्तिम-
स्याप्तं शोध्यमुपर्युपर्यथ घनेनैवं धनुष्यन्तत: ॥ ४३७ ॥

व्याख्या—1. A. तदूर्ध्वांश: ; C. तदर्धांश: 2. B. तथा

0′-0″-6‴ 0′-5″-12‴ 3′-9″-37‴ 71′-43″-24‴
'स्तेनः', 'स्त्रीपिशुनः', 'सुगन्धिनगनुद्', 'भद्राङ्गभव्यासनो'

872′-3″-5‴ 4241′-9″-0‴
'मीनाङ्गो नरसिंह', 'ऊनधनकृद्भूरेव' षट्स्वेषु तु ।
आधस्थ्याद् गुणिताविभीष्टधनुषः कृत्या विहृत्यान्तिम-
स्यातं शोध्यमुपर्युपर्यथ फलं स्यादुत्क्रमस्यान्त्यजम्" ॥ ४३८ ॥

व्यासार्धानयने यानि जातानीत्थं फलानि वै ।
ज्याशराविष्टधनुषस्तैस्त्रैराशिकतो भवेत् ।
अथवा ज्याशरावित्थं पृथक् तत्तत्फलैर्नयेत्[1] ॥ ४३९ ॥

['विद्वान्' इत्यादिवाक्यानां वासना]

निहत्य चापवर्गेण चापं तत्तत्फलानि च ।
हरेत् समूलयुग्वर्गैस्त्रिज्यावर्गहतैः क्रमात् ॥ ४४० ॥

चापं फलानि चाधोऽधो न्यस्योपर्युपरि त्यजेत् ।
जीवाप्त्यै, संग्रहोऽस्यैव[2] 'विद्वान्' इत्यादिना कृतः ॥ ४४१ ॥

निहत्य चापवर्गेण रूपं तत्तत्फलानि च ।
हरेद् विमूलयुग्वर्गैस्त्रिज्यावर्गहतैः क्रमात् ॥ ४४२ ॥

किन्तु व्यासबलेनैव[3] द्विघ्नेनाद्यं विभज्यताम् ।
फलान्यधोऽधः क्रमशो न्यस्योपर्युपरि त्यजेत् ॥ ४४३ ॥

शराप्त्यै, संग्रहोस्यैव 'स्तेन स्त्री'त्यादिना कृतः ।
न्यायेनानेन परिधिमिष्टव्यासस्य साधयेत् ॥ ४४४ ॥

तत्रेष्टव्यासपरिधिं प्रायिकं प्राक् प्रकल्पयेत् ।
उक्तन्यायेन परिधेरस्य तुर्यांशजं गुणम् ॥ ४४५ ॥

परिध्यष्टांशजत्वेन द्विघ्नव्यासे समानयेत् ।
तद्वर्गतद्व्यासवर्गभिदे दोःकोटिजे कृती ॥ ४४६ ॥

व्याख्या—1. C. पृथक्स्थं तत्फलैर्नयेत् 2. A. B. C. स्यैवं
3. C. व्यासभवेनैव

वास्तवस्य परिध्यष्टांशस्य दोःकोटिजीवयोः ।
वर्गात्तु व्यासवर्गार्धप्रमितौ स्तां मिथः समौ ॥ ४४७ ॥

यश्चासौ प्राथिकश्चापो यश्च ताविंतरेतरम् ।
कोटीवर्गहतौ व्यासवर्गाप्तौ यौ तयोर्भिदा ॥ ४४८ ॥

परिध्यष्टांशयोर्भेदजीवा सा कल्पिताम्ययोः ।
चापीकृत्य क्षिपेत्तां च त्यजेद्वा वृत्तपादतः ॥ ४४९ ॥

चतुर्गुणोऽयं परिधिरिष्टव्यासे स्फुटो भवेत् ।
इष्टव्यासेष्टपरिधितुर्यं चापं प्रकल्पयेत् ॥ ४५० ॥

निहत्य चापवर्गेण चापं तत्तत्फलानि च ।
हरेत् समूलयुग्वर्गैर्व्यासवर्गहतैः क्रमात् ॥ ४५१ ॥

चापं फलानि चाधोऽधो न्यस्योपर्युपरि त्यजेत् ।
शिष्टं [गुणस्य][1] वर्गो यो व्यासवर्गान्तरोऽपि यः ॥ ४५२ ॥

तयोर्यो बलमूले तद्भेदं स्वघनषष्ठतः ।
व्यासवर्गाप्तसंयुक्तं चतुघ्नं परिधेस्त्यजेत् ॥ ४५३ ॥

आद्यमूलेऽधिके, योज्यमूने, स्यात् परिधिः स्फुटः ॥ ४५४ ॥

[ज्यावर्गोपायः]

निहत्य चापवर्गेण चापवर्गं फलानि च ।
निरन्तरद्वयाविवर्गात् विमूलार्धहतैर्हरेत् ॥ ४५५ ॥

त्रिज्यावर्गैर्धनुर्वर्गमधोऽधस्तत्फलानि च ।
न्यस्योपर्युपरि त्याज्यमिष्टजीवाकृतिर्भवेत् ॥ ४५६ ॥

(—25) (+618)(—12,402) (+152,418)
'शौरि' 'जयति' 'रत्नौघपुष्टो' 'विश्वबराशयः' ।
(—13,90,528) (+78,90,136)
'जायमानान्धलोकेन' 'चण्डापन्नाधिविरसुना' ॥ ४५७ ॥

व्याख्या—1. A. गुणोऽतस्य ; B. C. गुणोऽस्य

[माधवोदितं ज्याचापानयनम्]

इति ज्याचापयोः कार्यं ग्रहणं माधवोदितम् ।
विधान्तरं च तेनोक्तं तयोः सूक्ष्मत्वमिच्छताम् ॥ १५ ॥

(—2,39,83,139)   (+2,91,60,000)
'धीगापाङ्गजळाङ्गस्त्री', 'नानाज्ञानतपोधरः' ।
एतेऽष्टाऽस्वधोधस्याविष्टचापकृतिघ्नतः ॥ ४५८ ॥

अन्त्यचापस्य कृत्याप्तमुपर्युपरि शोधयेत् ।
अन्ते लब्धस्य यन्मूलं तदभीष्टगुणो भवेत् ॥ ४५९ ॥

उक्तप्रकारे कृत्स्नज्यैवेच्छाराशिः प्रकल्पिता ।
वक्ष्यमाणे पुनश्चापभागार्धज्या प्रकल्प्यते ॥ ४६० ॥

इति ।

[माधवोक्तं ज्याचापानयनम्]

इति ज्याचापयोरिति (II. 15)

[1]द्वितीयज्याग्रमभितो धनुर्भागद्वयान्तरे ।
स्पृष्टोभयाग्रा कृत्स्नज्याचापभागद्वयस्य या ॥ ४६१ ॥

तन्मध्यगामि व्यासार्धं कर्णोऽपि परिकल्प्यते ।
यस्य द्वितीयतत्कोट्यौ दोःकोटिज्ये व्यवस्थिते ॥ ४६२ ॥

चापांशयोः समस्तज्या या द्वितीयतृतीययोः ।
तन्मध्यगामिव्यासार्धात् तृतीयधनुरग्रगः ॥ ४६३ ॥

खण्डस्तस्य द्वितीयज्या कर्णोऽसौ व्यस्तदिङ् मतः ।
दोःकोट्यौ च तयोर्व्यस्तदिशोः कर्णवशादिह ॥ ४६४ ॥

द्वितीयज्याहतं कृत्स्नज्यार्धं तत् त्रिज्यया हृतम् ।
कृत्स्नज्यामध्यतः कोटीखण्डं पूर्वापरायतः ॥ ४६५ ॥

व्याख्या—1. Verses 461-79 are the same as *Kriyākramakarī* verses 82-101 on *Līlāvatī*, 190, (Edn., pp. 358-60).

द्वितीयकोटिगुणितस्तद्वत् त्रिज्यासमुद्धृतः ।
भवेत् तृतीयचापाग्राद् दोःखण्डा दक्षिणोत्तराः ॥ ४६६ ॥

समस्तज्याशरोनं यद्व्यासार्धं तद्धते उभे ।
द्वितीयबाहुकोटिज्ये त्रिज्याप्ते यत् फलद्वयम् ॥ ४६७ ॥

कृत्स्नज्याशरहीन[स्य] व्यासार्धस्य तदन्तरम् ।
भवेत् पूर्वापरात् सूत्रात् तथा याम्योत्तरावपि ॥ ४६८ ॥

कृत्स्नज्योत्क्रमहीनायास्त्रिज्याया बाहुकोटिके ।
समस्तज्यावलोत्पन्नं दोःखण्डं तत्र दोर्गणे ॥ ४६९ ॥

प्रक्षिपेत् कोटिखण्डं च त्यजेत् कोटिगुणात् ततः ।
स्यातां तृतीयचापाग्रो दिक्सूत्रद्वितयाद् गुणौ ॥ ४७० ॥

दोःखण्डो दोर्गुणात् त्याज्यः क्षेप्यं कोट्यां तथेतरः ।
दिक्सूत्रद्वितयाद्वाद्यचापाग्रे बाहुकोटिके ॥ ४७१ ॥

कृत्स्नज्यावलयोः श्रुत्योर्दोःकोट्यौ द्वे समे यतः ।
कृत्स्नज्यामध्यतः कोटीखण्डः पूर्वपरायतः ॥ ४७२ ॥

तृतीयज्यावधिः कोटिः सैव तत्खण्डयोर्द्वयोः ।
खण्डः सौम्योऽत्र[1] दोर्ज्या स्यात् कृत्स्नज्यार्धं हि यच्छ्रुतिः ॥ ४७३ ॥

द्वितीयज्याहृता कृत्स्नज्याशरोना त्रिमौर्विका ।
त्रिज्याप्ता याम्यखण्डः स्याद् द्वितीयज्या च तच्छ्रुतिः ॥ ४७४ ॥

कोट्या त्रिमौर्व्या गुणनात् त्रिज्यया हरणादपि ।
द्वितीयमौर्वी यत्रेच्छा प्रमाणं च त्रिमौर्विका ॥ ४७५ ॥

त्रिज्यायाः कर्णरूपत्वाद् द्वितीयस्याश्च कर्णता ।
प्रमाणफलयोर्दिङ्नियमस्त्वनुभूयते ॥ ४७६ ॥

इच्छातत्फलयोस्ताद्दृङ्नियमः परिकल्प्यते ।
द्वितीयज्यां तृतीयज्यातत्पूर्वापरसूत्रयोः ॥ ४७७ ॥

व्याख्या—1. A. B. सौम्येऽत्र ; C. साम्येऽत्र

सम्पाततः समस्तज्यामध्यां तां परिकल्पयेत् ।
कृत्स्नज्यार्धद्वितीयज्या तृतीयज्या च बाहवः ॥ ४७८ ॥

लम्बः साधारणी कोटिस्ताहृक् द्वयधं भवेत् ततः ।
[1]अन्तरं प्रथमज्या स्यात् तयोः कोटयौ तु पूर्ववत् ॥ ४७९ ॥

न्याययोरनयोरेकेनेत्थं जीवाः क्रमान्नयेत् ।
धनुर्मध्यगता कोटिरेकराशिज्यया समा[2] ॥ ४८० ॥

चापे द्वितीयराश्यन्तमभितः सार्धकल्पिते ।
चापभागस्य कृत्स्नज्या दलराशिज्यया हृते ॥ ४८१ ॥

कोटया त्रिज्याहृते स्यातां कृत्स्नज्यादलयोर्दले ।
कृत्स्नज्यार्धं हि चापार्धस्यार्धज्या सर्वदा मता ॥ ४८२ ॥

अतस्तत्पार्श्वयोश्चापभागार्धज्यादलान्वयात् ।
आद्यपिण्डो, द्वितीयोऽथ तत्पार्श्वद्वययोगतः ॥ ४८३ ॥

तृतीयाद्याश्च पिण्डाः स्यु[3]र्योगात् तत्पार्श्वखण्डयोः ।
एवं द्वितीयराश्यन्तमभितो ये क्रमोत्क्रमात् ॥ ४८४ ॥

तेषां द्वयोर्द्वयोर्योगात् क्रमपिण्डाः स्युराचितः ।
पिण्डज्याः स्युस्ततः पिण्डद्वययोगात् क्रमोत्क्रमात् ॥ ४८५ ॥

अन्त्यराशिगुणात् सिद्धधन्त्यन्त्ययोगेन तद्यथा ।
प्रथमस्याद्यया युक्ता द्वितीयोपान्त्यमौर्विका ॥ ४८६ ॥

अन्त्यराशौ भवेदाद्या तद्गूर्ध्वाधस्त्ययोर्युतिः ।
तृतीयमे द्वितीया स्यादेवं भूयोऽपि योजयेत् ॥ ४८७ ॥

व्याख्या—1. The *Kriyākramakarī* passage, (Edn. p. 360), has two extra lines before this :

कृत्स्नज्यार्धद्वितीयज्यावर्गयोर्लम्बजां कृतिम् ॥ 100b ॥
त्यक्त्वा तन्मूलयोर्योगस्तृतीयज्या भवेत् ततः ॥ 101a ॥

2. A. समे

3. C. Hapl. om. after स्यु to स्यु, two lines below.

इत्थं राश्योर्द्वयोर्ज्याभिस्तृतीयस्य प्रसाधिता ।
आद्यद्वितीययो राश्योस्तद्वदाद्यतृतीययोः ॥
तृतीयमध्यराश्योश्च ज्याभिरन्याः प्रसाधयेत् ॥ ४८८ ॥

[लम्बानयनवासना]

यदुक्तं "जीवयोर्घाताद् व्यासाप्तो लम्ब" इत्यतः ।
अस्योपपत्तिः पठितव्या[1] एवोद्दिश्य वर्ण्यते ॥ ४८९ ॥

तत्र तावत्र जीवोन्मानेन वृत्तं लिखेत् ततः ।
पूर्वापरां दक्षिणोदग्रेखां च विलिखेदिह ॥ ४९० ॥

चापभागेषु सर्वत्र बिन्दूंश्च तनुतं [वृत्तौ][2] ।
पूर्वापरा या रेखा तत्प्रागग्रावुभयोरपि ॥ ४९१ ॥

तत्पार्श्वयोश्चापभागेष्वेकैकान्तरिताः क्रमात् ।
समयाम्योत्तरा रेखा यास्त्याज्या प्रथमादिताः ॥ ४९२ ॥

प्राग्ज्यार्धाभ्युदितान्यत्र द्विगुणंरच्यते विधिः ।
तत्र षष्ठीचतुर्थ्योर्जीवयोर्लम्बविधिर्यदा ॥ ४९३ ॥

तदा प्रागग्रतः प्राक्सूत्रस्य तत्पार्श्वयोः पृथक् ।
चापखण्डानतिक्रम्य दश याम्योत्तरं स्थिता ॥ ४९४ ॥

या रेखा प्रोक्तचापद्वितय[3]योगभवा च सा ।
दशमी लम्बमूल[4]स्पर्शिनी जीवा च सा ततः ॥ ४९५ ॥

अस्याः प्रवृत्ता याम्याग्रा पूर्वोत्तरमुखी पराम् ।
स्पृष्टोभयाग्रां परिधौ खण्डद्वादशकोद्भवाः ॥ ४९६ ॥

षष्ठीं जीवां लिखेदस्या उत्तराग्रं तदा वृत्तौ ।
खण्डद्वयान्ते स्पृशति प्राक्सूत्राग्रस्य[5] तूत्तरे ॥ ४९७ ॥

व्याख्या—1. Mss. read परितः ज्या
2. The mss. read वृता
3. Mss. read चाल्पद्वितय
4. A. दशमी मूलंबमूलंब (wr.)
5. C. प्राग्रेखाग्रस्य

ततः षष्ठ्या दशम्याश्च जीवायाश्चोत्तराग्रयोः ।
स्पृष्टोभयाग्रापरिधौ चतुर्थी ज्या भवेत्तदा ॥ ४९८ ॥

षष्ठीचतुर्थ्यग्रयुते दशम्यान्तश्च लम्बतः[1] ।
तदानयनयुक्त्यर्थं षष्ठज्याचापमध्यतः ॥ ४९९ ॥

वृत्तकेन्द्रानुसारेण व्यासरेखां लिखेत्ततः ।
सा स्यात् कर्णोऽस्य कर्णस्य पूर्वाग्रात् समपश्चिमम्[2] ॥ ५०० ॥

प्रवृत्ता या परिध्यन्ता रेखा सा कोटिका ततः ।
समोत्तरं प्रवृत्तज्या कोटिकर्णयुतेर्भुजा ॥ ५०१ ॥

यन्मध्यतः प्रवृत्तैषा तुल्या तदितरेण सा ।
इष्टयोर्जीवयोर्यस्याः प्रवृत्ता चापमध्यतः ॥ ५०२ ॥

भुजा तदितरैषा स्याच्चापखण्डाष्टकाश्रयात् ।
पूर्वसूत्राग्रतश्चापयोगार्धप्रमिता द्वयोः ॥ ५०३ ॥

पार्श्वयोर्ये परिध्यंशे जीवे तन्मध्यगे उभे ।
इष्टस्य धनुषस्त्यक्ते चार्धे योगार्धतस्ततः ॥ ५०४ ॥

शिष्टं तदितरार्धं स्यादन्यपार्श्वेऽपि तन्मिते ।
स्पृष्टोभयाग्रा यच्चापमध्याग्रा सा निजेतरः ॥ ५०५ ॥

षष्ठज्या चापमध्याग्रा चतुर्थी ज्या भवेत्ततः ।
चतुर्थचापमध्याग्रा स्थित्थं षष्ठी भवेदपि ॥ ५०६ ॥

त्र्यश्रद्वयं प्रमाणं स्यादेतदिच्छाद्वयं पुनः ।
समानलम्बभुजकमिष्टज्याद्वयकर्णकम् ॥ ५०७ ॥

लम्बच्छिन्नौ तु यौ खण्डौ भुवस्तत्कोटिकं भवेत् ।
दिग्वैपरीत्यतः साम्यं वेद्यमिच्छाप्रमाणयोः ॥ ५०८ ॥

दिक्साम्याद् वैपरीत्याद् वा कर्णयोरथवान्ययोः ।
तुल्याकारत्वमिच्छाप्रमाणयोः क्षेत्रयोर्भवेत् ॥ ५०९ ॥

व्याख्या—1. A. लम्बकः 2. B. पश्चिमः

['जीवे परस्पर'-न्यायः]

जीवे परस्परनिजेतरमौर्विकाभ्या-
मभ्यस्य विस्तृतिदलेन विभाज्यमाने ।
अन्योन्ययोगविरहानुगुणे भवेतां
यद्वा स्वलम्बकृतिभेदपदीकृते द्वे ॥ १६ ॥

['जीवे परस्पर'-न्यायाविष्करणम्]

क्षेत्रं यदिष्टज्याचापमध्यसंस्पृष्टकर्णकम् ।
इष्टज्याकर्णकेनैतत्क्षेत्रेण सदृशाकृति ॥ ५१० ॥

इष्टेतरेण तन्मध्यस्पृक्कर्णं सदृशं तथा ।
यन्मध्यगं यद्व्यासाग्रं ते द्वे चेच्छाप्रमाणके ॥ ५११ ॥

प्रमाणस्य फलं व्यासाग्रस्पृष्टान्यमिता भुजा ।
इतरव्यासकर्णाग्रस्पृष्टेष्टज्या च तत्फलम् ॥ ५१२ ॥

इष्टेतरज्ययोर्लम्बः सममिच्छाफलं द्वयोः ।
इष्टेतरज्ययोर्घाताद् व्यासाप्तो लम्बको हृतः ॥ ५१३ ॥

अथेष्टेतरयोः कोटी ज्ञातव्ये यदि ते उभे ।
इष्टेतरज्ये हत्वा स्वेतरकोट्या हरेत् पुनः ॥ ५१४ ॥

व्यासेन लब्धे भूखण्डे स्वस्वकोटीफले च ते ।
अथ लम्बकृतिं साधारणीमिष्टेतरज्ययोः ॥ ५१५ ॥

कृत्योर्विशोध्य ये मूले ते वा कोटिफले उभे ।
चापयोगस्य जीवैवा येत्थं नीता यथोदितम् ॥ ५१६ ॥

"जीवे परस्परनिजेतरमौर्विकाभ्या-
मभ्यस्य विस्तृतिदलेन विभज्यमाने ।
अन्योन्ययोगविरहानुगुणे भवेतां
यद्वा स्वलम्बकृतिभेदपदीकृते द्वे" ॥ ५१७ ॥

अत्र व्यासेन हरणे वक्तव्ये व्यासखण्डतः ।
यदुक्तहरणं तत्तु जीवार्धानां विवक्षया ॥ ५१८ ॥

इष्टज्याकर्णकक्षेत्रद्वयकोट्योर्युतिस्तु या[1] ।
सेष्टज्या[2]चापयोगस्य जीवा स्यादिति वर्णितम् ॥ ५१९ ॥

अथ कोटीफलमिवा या सा चापान्तरज्यका ।
महाकोट्यग्रतः स्वल्पकोटितुल्ये विशोधिते ॥ ५२० ॥

मध्यतस्तत्र यच्छिष्टमूर्ध्वमुत्सर्पयेच्च तत् ।
स्पृशेद् यथाग्रद्वितयं परिधिं सान्तरज्यका ।
जीवायोगान्तरन्याय:[3] कृत्स्नज्यास्वपि दृश्यते ॥ ५२१ ॥

[व्यासार्धमन्तरा ज्यानयनम्]

[i. त्र्यश्रक्षेत्रन्यायः]

"त्रिभुजे भुजयोर्योगस्तदन्तरगुणो भुवा हृतो लब्ध्या ।
द्विष्ठा भूरूनयुता दलिताबाधे पृथक् स्याताम् ॥ ५२२ ॥

स्वाबाधाभुजकृत्योरन्तरमूलं प्रजायते लम्बः ।
लम्बगुणं भूम्यर्धं स्पष्टं त्रिभुजे फलं भवति" ॥ ५२३ ॥

(लीलावती १६५-६६)

इति ।

[4]कर्णयोर्वर्गभेदो यः स एवाबाधयोरपि ।
लम्बाबाधावर्गयोगः कर्णवर्गो भवेदिह ॥ ५२४ ॥

लम्बस्य कृतिरेकैव कर्णयोरुभयोः स्थिता ।
आबाधावर्गभेदेन भुजयोर्वर्गान्तरं ततः ॥ ५२५ ॥

व्याख्या—1. A. युतिर्यया 2. C. इष्टज्या

3. A. C. न्याया

4. Verses 524-31 are the same as in *Kriyakramakarī*, verses 1-8 on the *Līlāvatī*, 165-68 (edn., p. 317).

वर्गान्तरे[1] ततस्तुल्ये श्रुत्योराबाधयोरपि ।
वर्गान्तरं च योगोन्तराभ्यास: प्रागुदीरित: ।। ५२६ ।।

श्रुत्योर्योगान्तराभ्यास: [2]स एवाऽबाधयोरपि ।
श्रुतिद्वयेन त्रिभुजे भुजाद्वितयमुच्यते ।। ५२७ ।।

आबाधालम्बयो:कोट्यो: श्रुतिभूते च तद्भुजे ।
त्रिभुजे भुजयोर्योगस्तदन्तरगुणस्तत: ।। ५२८ ।।

भुवाबाधान्तरं लब्धमाबाधायोगतुल्यया ।
योगान्तराभ्यामाबाधाद्वयसङ्क्रमणात् तत: ।। ५२९ ।।

लम्बवर्गान्तरपदं स्वाबाधाभुजयोर्भवेत् ।
भूम्यर्धं लम्बनिहतं त्र्यश्रक्षेत्रफलं भवेत् ।। ५३० ।।

लम्बान्यपार्श्वेऽप्येतादृक्क्षेत्रं यत्र प्रकल्प्यते ।
त्र्यश्रयोरुभयोर्मध्ये यथा लम्ब: पतेत् तथा ।। ५३१ ।।

विपर्ययेण सन्धानात् त्र्यश्रयो: स्याच्चतुर्भुजम् ।
चतुर्भुजान्तस्त्रिभुजद्वितयं युज्यते यत: ।। ५३२ ।।

लम्बैकपार्श्वे यत् त्र्यश्रं यावृङ्निम्नं भवेदिह ।
तदन्यपार्श्वत्र्यश्रेण तावृङ्निम्नेन तद्युतम् ।। ५३३ ।।

भवेच्चतुर्भुजं यद्वत्तयार्धद्वययोगत: ।
भुजा भूमिर्भवेदाद्ये भूम्यर्धमितरत्र च ।।
लम्ब: कोटिश्च भूम्यर्धलम्बघातफलं तत: ।। ५३४ ।।

[ii. वृत्तगतचतुरश्रक्षेत्रन्याय:]

"कर्णाश्रितभुजाघातैक्यमुभयथान्योन्यभाजितम् गुणयेत् ।
योगेन भुजप्रतिभुजवधयोर्मूले श्रुती भवत: ।। ५३५ ।।

(लीलावती, १८८)

इति ।

व्याख्या—1. A. B. C read वर्गान्तरं; वर्गान्तरे adopted from the *Kriyakramakarī* passage.

2. A. B. C. read सन्निव ; स एव in *Kriyākramakarī*.

[1]चतुर्भुजं[2] यद् विषमं वृत्तान्तर्भागसंस्थितम् ।
तन्नेमिस्पृष्टतत्कोणः कर्णस्तत्र भवेद्यथा ॥ ५३६ ॥

तद्भुजा महती भूमिर्मुखं स्वल्पा च तद्भुजा[3] ।
पार्श्वे, तद्भुजयोः सौम्या स्वल्पा स्यान्महतीतरा ॥ ५३७ ॥

अन्योन्यप्रति[4]बद्धाग्राश्चतस्रोऽप्यत्र ता भुजाः ।
नेमिस्पृष्टोभयाग्रत्वात् कृत्स्नज्यावदवस्थिताः ॥ ५३८ ॥

तद्भुजाभिश्चतसृभिर्वृत्तं कार्त्स्न्येन पूर्यते ।
तत्र चापद्वययुतेर्जीवा कर्णतया स्थिता ॥ ५३९ ॥

तत्कर्णभूमितत्पार्श्वभुजाश्रितयवोर्युगम्[5] ।
त्रिभुजद्वितयं कल्प्यं तस्य कर्णस्य पार्श्वगम् ॥ ५४० ॥

[6]एवमेवान्यकर्णेन तद्भूमित्रिभुजद्वयम् ।
त्रिभुजे भुजयोर्योगस्तदन्तरसमाहतः ॥ ५४१ ॥

तयोराबाधयोर्योगान्तराभ्यासो भवेदिह ।
चापयोगसमस्तज्या भवेदाबाधयोर्युतिः ॥ ५४२ ॥

तच्चापान्तरकृत्स्नज्या भवेदाबाधान्तरं तथा ।
यदाऽऽबाधान्तरमुखं क्षेत्रं तद्योगभूमिकम् ॥ ५४३ ॥

चतुरश्रं भुजा तत्र महत्यल्पसमा यदा ।
कल्प्यते समलम्बत्वं क्षेत्रस्यास्य भवेत् ततः ॥ ५४४ ॥

लम्बाग्रयोर्यद्विवरं तत्राऽऽबाधान्तरं तु यत् ।
चापान्तरसमस्तज्या स्यादाबाधान्तरं ततः ५४५ ॥

व्याख्या—1. Verses 536-616a are the same as *Kriyākramakarī*, verses 1-81, on *Līlāvatī*, 188-90, (Edn., pp. 351-58).

2. A. B. C. चतुर्भुजे ; चतुर्भुजं in *Kriya.* passage.

3. A. B. C. तद्भुजाम् ; तद्भुजा in *Kriya.* passage.

4. C. अन्योन्यस्याति

5. A. B. C. द्वितपयोर्युगम् ; *Kriya.* °वोर्युगम्

6. A. B. एवमेवास्य ; C. एवमेवान्यकर्णोऽन्य ; *Kriya.* एवमेवान्य

चतुरश्रस्थिते पार्श्वभुजे स्यातां समे यदि ।
लम्बयोरुभयो: साम्यं तदीयाबाधयोरपि ॥ ५४६ ॥

लम्बान्तरं यद् भूमिष्ठं तदाबाधान्तरं भवेत् ।
लम्बाग्रविवरं चापि तदेव स्याद् यतस्तत: ॥ ५४७ ॥

चापान्तरसमस्तज्या साऽऽबाधान्तरसम्मिता ।
चापयोगस्य या जीवा या तच्चापान्तरस्य च ॥ ५४८ ॥

तत्संवर्गसमं वर्गान्तरं तद्धनुषोर्ज्ययो: ।
भुजायोगान्तराभ्यासो भवेदाबाधयोरपि ॥ ५४९ ॥

चापयोरल्पमहतोर्जीवे चात्र भुजे मते ।
चापद्वयसमस्तज्ये ये त्वत्र विदिते उभे ॥ ५५० ॥

तयोर्योगान्तरज्यात्वमुभयो: परिकल्पयेत् ।
तयोर्ज्ययोर्य: संवर्गो वर्गान्तरसमोऽत्र स: ॥ ५५१ ॥

तच्चापयोगभेदार्धभवयोर्जीवयोर्द्वयो: ।
ययोर्ज्ययोर्य: संवर्ग: स तु तच्चापयोर्द्वयो: ॥ ५५२ ॥

योगान्तरार्धोद्भवयोर्ज्ययोर्वर्गान्तरं भवेत् ।
वर्गान्तरं ययोस्तद्वज्जीवयोरुभयोरपि ॥ ५५३ ॥

तच्चापयोगान्तरोत्थज्ययोर्घातो भवेत्तु स: ।
कर्णानयनयुक्त्यर्थमिदं वेद्यं हि धीमता ॥ ५५४ ॥

[iii. वृत्तगतचतुरश्रकर्ण:]

घातवर्गान्तरन्यायो ज्ययो: सर्वत्र कल्प्यताम् ।
स वर्गान्तरसंवर्गन्यायो ज्ञेय: प्रयत्नत: ॥ ५५५ ॥

योगान्तरार्धयोर्घाताद् वेद्यं वर्गान्तरं तत:[1] ।
वर्गान्तरे तु विदिते तत्संवर्गो भवेदपि ॥ ५५६ ॥

तच्चापयोर्योगभेदभवयोर्जीवयोर्द्वयो: ।
योगान्तरार्धं धनुषोर्ज्ययोर्वर्गान्तरं भवेत् ॥ ५५७ ॥

व्याख्या—1. B. वर्गान्तरात् तत:

[1]तत्र ज्ययोर्ययोर्घातः कर्णाग्राश्रितयोः[2] कृतः ।
तच्चापद्वययोगार्धस्यान्तरार्धस्य च द्वयोः ॥ ५५८ ॥

वर्गान्तरसमस्तत्कर्णान्याग्रेऽपि तथैव च ।
तत्राल्पज्याग्रतश्चापान्तरतुल्ये महत्यतः ॥ ५५९ ॥

बिन्दौ कृते तद्विवरं तच्चापान्तरमौर्विका ।
ततः शिष्टमहाचापं स्वल्पचापसमं भवेत्[3] ॥ ५६० ॥

इतराग्रेऽपि कर्णस्य चापान्तरगुणस्तथा ।
कर्णाग्रद्वितयस्पृष्टं तत्र रूपान्तरद्वयम् ॥ ५६१ ॥

तयोर्ज्ययोर्मध्यगतां व्यासरेखां च कल्पयेत् ।
ज्यामूलाच्चापयोगार्धं व्यासाग्रस्यान्तरं भवेत् ॥ ५६२ ॥

ततः कर्णाग्रयोश्चापयोगार्धद्वितयं तु यत् ।
परिध्यर्धसमं तत् स्याद्व्यार्धमपि तादृशम् ॥ ५६३ ॥

तदग्रद्वितयस्पृष्टा व्यासरेखा भवेदिह ।
द्वेधा भक्ते परिध्यर्धे परिधेश्चतुरंशके ॥ ५६४ ॥

तज्ज्यावर्गयुतिः कर्णवर्गो व्यासकृतेः समः ।
चापयोरन्तरार्धोत्थज्ययोर्वर्गान्तरं ततः ॥ ५६५ ॥

चतुर्भुजं स्वल्पमुखं यन्महद्भुजभूमिकम् ।
शिष्टयोर्भुजयोर्गुर्वी याम्यसौम्या तथेतरा ॥ ५६६ ॥

याम्याद् भूम्यग्रतः सौम्यमुखाग्रान्ता च तच्छ्रुतिः ।
उदग्भूम्यग्रतो याम्यमुखाग्रान्ता तथेतरा ॥ ५६७ ॥

उदग्भूम्यग्रतः सौम्यचापे मुखधनुर्मिते ।
बिन्दुस्तन्मुखसौम्याग्रमध्ये व्यासाग्रमिष्यते ॥ ५६८ ॥

सौम्याद् भूम्यग्रतो याम्यभुजाचापान्तरेऽन्ततः ।
बिन्दुरन्यस्ततो[4] भूमेर्याम्याग्रान्तरमध्यगम् ॥ ५६९ ॥

व्याख्या—1. C. तत् त्रिज्ययो 2. C. कर्णाग्रश्रुतयोः
3. C. Hapl. om. of three lines after भवेत्
4. C. Hapl. om. after ततो to ततो, three lines below.

व्यासमूलं ततो भूमेर्याम्याग्रविवरं[1] तु यत् ।
अन्तरार्धसमं[2] तत्तु [3]याम्ययोर्भूमिचापयोः ॥ ५७० ॥

ततो याम्यभुजोर्ध्वाग्रं सौम्याग्रं च भुवस्ततः[4] ।
विवरद्वितयं तुल्यं चापयोगार्धसम्मितम् ॥ ५७१ ॥

व्यासाग्रान्मुखयाम्याग्रोदग्वोर्मूले उभे समे ।
मुखसौम्यभुजाघातो याम्यभूम्योश्च यो वधः ॥ ५७२ ॥

तद्योगः कर्णमूलाग्रद्वयवोर्वधयोर्युतिः ।
मुखसौम्यभुजाचापद्वययोगान्तरार्धयोः ॥ ५७३ ॥

ज्ययोर्वर्गान्तरसमो मुखसौम्य[5]भुजावधः ।
भूमियाम्यभुजाचापद्वययोगान्तरार्धयोः ॥ ५७४ ॥

ज्ययोर्वर्गान्तरसमो भूमियाम्यभुजावधः ।
आद्यकर्णाग्रसंस्पृष्टचापयोगदलं तु यत् ॥ ५७५ ॥

यच्च तन्मूलसंस्पृष्टचापयोगदलं परम् ।
चापार्धयोस्तयोर्योगः परिध्यर्धसमो भवेत् ॥ ५७६ ॥

चापयोगद्वययुतिर्यतः[6] परिधिसम्मिता[7] ।
वर्गयोगो व्यासवर्गश्चापयोगार्धजीवयोः ॥ ५७७ ॥

परिध्यर्धे द्विधा भक्ते कृत्स्नज्ये भागयोर्द्वयोः ।
व्यासकर्णस्य दोःकोटिरूपत्वेन व्यवस्थिते ॥ ५७८ ॥

तयोर्वर्गयुतिस्तस्माद् व्यासवर्गसमा मता ।
योगार्धज्यावर्गयोगो वर्गयोगसमोऽत्र यः ॥ ५७९ ॥

चापान्तरार्धज्यावर्गद्वयेन रहितस्ततः[8] ।
कर्णाश्रितभुजाघातद्वययोगसमो भवेत् ॥ ५८० ॥

व्याख्या—1. A. B. यामाग्रविवरं 2. A. C. अन्ताग्रान्तसमं
3. B. याम्या वोर्भूमि 4. A. C. तथा
5. B. मूलसौम्य 6. A. B. C. युतः
7. B. सम्मता 8. A. C. तथा

तत्र चापान्तरार्धज्यावर्गयोर्व्यासवर्गतः ।
शोध्ययोरुभयोरेकं वर्गं प्रथमतस्त्यजेत् ॥ ५८१ ॥

शिष्टं वर्गान्तरं व्यासस्यान्तरार्धस्य चोभयोः ।
योगान्तरोत्थज्याघातसमं वर्गान्तरं च तत् ॥ ५८२ ॥

चापान्तरार्धयुक्तोनपरिध्यर्धं च तद्धनुः ।
तत्र ज्ययोर्द्वयोः साम्याद् घातो वर्गसमस्तयोः ॥ ५८३ ॥

परिध्यर्धस्य या जीवा कृत्स्नव्याससमा हि सा ।
तुल्यान्तरितयोर्व्यासाज्जीवे तत्पार्श्वयोः समे ॥ ५८४ ॥

इष्टोनयुक्तपरिधिदल[1]ज्ये द्वे समे ततः ।
तुल्ययोस्तु ज्ययोर्घातस्तद्वर्गप्रमितो मतः ॥ ५८५ ॥

अन्तरार्धोनपरिधिदलज्याकृतिरेव तत् ।
कर्णाग्रद्वितयोद्भूतभुजाघातयुतिर्भवेत् ॥ ५८६ ॥

नेम्यर्धस्य [तदग्रोत्थ][2]चापान्तरदलस्य च ।
ज्ययोर्वर्गान्तरात् साध्यं तद्धनुर्योगभेदयोः ॥ ५८७ ॥

जीवयोरुभयोर्घातस्तत्र [गुण्यगुणौ][3] समौ ।
नेम्यर्धयोर्द्वयोः साम्यादन्तरार्धोनयुक्तयोः ॥ ५८८ ॥

तदूनं यत्परिध्यर्धं यदन्यार्धं च तद्युतम् ।
एकैव हि तयोर्जीवाघातो वर्गस्तयोस्ततः ॥ ५८९ ॥

समद्विघातः सर्वत्र वर्गरूपो भवेद्यतः ।
मुखोदगग्राद् व्यासाग्रविवरे प्राग् विशोधिते ॥ ५९० ॥

नेम्यर्धमुखसौम्याग्राद् व्यासान्याग्रावधि स्मृतम् ।
व्यासेतराग्रतो भूमेर्याम्याग्रावधिकोऽपि यः ॥ ५९१ ॥

परिध्यंशोऽथ तस्य स्यादन्तरार्धगुणोऽपरः ।
मुखोदगग्राद् व्यासेतराग्रान्तो[4] धनुरंशकः ॥ ५९२ ॥

व्याख्या—1. A. B. C. दलं 2. A. B. C. तदर्धोत्थ
3. A. B. C. गुण्यगुणा 4. C. राग्रांशो

चापान्तरार्धमपरं यच्च वर्गान्तरात् तयोः ।
जीवयोश्चयोर्घातिस्तद्धनुर्योगभेदतः ॥ ५९३ ॥

वर्गान्तरं द्वयो राश्योः संवर्गात्मकमेव हि ।
मुखोग्रगप्राचा याम्यभुजाभूम्यग्रसङ्गमम् ॥ ५९४ ॥

आ च भूमिष्ठबिन्द्वन्तं परिध्यंशावुभौ च यौ ।
तज्ज्याघातो भवेद् व्यासवर्गो वर्गद्वयोनितः ॥ ५९५ ॥

मुखग्राम्यभुजाचापयोगज्याद्यात्र कल्पिता ।
मुखभूचापयोगज्या द्वितीया च प्रकल्पिता ॥ ५९६ ॥

यतो याम्यभुजाचापं तद्भूचापान्तरान्वितम् ।
कृत्स्नेन भूमिचापेन तुल्यमेव तु तद् भवेत् ॥ ५९७ ॥

तत्र ज्ययोर्ययोर्घातः स कर्णः प्रथमो मतः ।
मुखग्राम्यभुजाचापयोगज्या कर्ण आदिमः ॥ ५९८ ॥

तृतीयकर्णस्त्वन्यः स्याद् व्यस्तन्यस्ते भुजाद्वये ।
द्वितीयो भूमिसौम्याग्रान्मुखयाम्याग्रगो मतः ॥ ५९९ ॥

तयोर्व्यत्यस्तयोः कर्णः प्राच्य एव भवेत् सदा ।
आद्यान्त्यकर्णसम्पातो मुखसौम्याग्रगो भवेत् ॥ ६०० ॥

आद्यकर्णस्य चान्याग्रं याम्यदोर्भूमिसङ्गमे ।
तृतीयकर्णस्यान्याग्रं भूचापस्थितबिन्दुगम् ॥ ६०१ ॥

भूमिसौम्यभुजाचापान्तरतुल्यं तदन्तरम् ।
आद्यान्त्यकर्णद्वितयदोर्युगं त्रिभुजं ततः ॥ ६०२ ॥

कर्णेतराग्रविवरभूमिकं परिकल्पयेत् ।
त्रिभुजे भुजयोर्घाताद् व्यासभक्तः स लम्बकः ॥ ६०३ ॥

तच्चापद्वययोगज्याभूमिके त्रिभुजे ततः ।
आद्यान्त्यकर्णयोरत्र भुजात्वेन प्रकल्पनात् ॥ ६०४ ॥

तद्घाताद् व्यासविहृतस्तत्र लम्बो भवेत् स्फुटः ।
द्वेधा द्वितीयकर्णेन विभक्तेऽस्मिश्चतुर्भुजे ॥ ६०५ ॥

तत्कर्णपार्श्वयोस्त्र्यश्रद्वयं तद्भूमि कल्पयेत् ।
तल्लम्बद्वययोगेन समो नीतोऽत्र लम्बकः ॥ ६०६ ॥

आद्यान्त्यकर्णद्वितयबोर्युगत्रिभुजस्य च ।
तच्चापद्वययोगज्याभूमिकस्य स लम्बकः ॥ ६०७ ॥

कर्णद्वयाश्रितभुजाघातैक्यद्वितयं त्विह ।
भुजप्रतिभुजाभ्यासयुतिश्चेति युतित्रयम् ॥ ६०८ ॥

कर्णमूलस्थयोर्दोष्णोर्घातोऽग्राश्रितयोरपि ।
कर्णाश्रितभुजाघातद्वयं या तु[1] तयोर्युतिः ॥ ६०९ ॥

एकं कर्णाश्रितभुजाघातैक्यं तत् प्रकीर्तितम् ।
द्वितीयकर्णाश्रितयोर्घातैक्यमपरं तथा ६१० ॥

भुजप्रतिभुजाभ्यासद्वययोगोऽन्तिमो वधः ।
मुखसौम्यभुजाघातो याम्यभूम्योश्च यो वधः ॥ ६११ ॥

आद्यान्त्यकर्णसंवर्गस्तयोर्घातयुतिर्भवेत् ।
तत्र स्वल्पभुजाचापयोगज्यैकाऽपरा पुनः ॥ ६१२ ॥

द्वयोरप्यल्पमहतोश्चापयोगज्यका मता ।
द्वितीयकर्णाग्रोद्भूतभुजाद्वयवधोऽत्र यः ॥ ६१३ ॥

तत्कर्णमूलसंस्पृष्टभुजाद्वयवधोऽपरः ।
मुखयाम्यभुजाघात आद्यस्तत्र प्रकल्पितः ॥ ६१४ ॥

भूमिसाम्यभुजाघातो द्वितीयश्च द्वयोर्वधः ।
तयोर्योगो भूमुखयोर्भुजयोर्याम्यसौम्ययोः ॥ ६१५ ॥

योगज्ययोर्द्वयोर्घातः श्रुत्योरन्त्यद्वितीययोः ।
भुजप्रतिभुजाभ्यासयोग आद्यद्वितीययोः[2] ॥ ६१६ ॥

श्रुत्योर्वधः स्यादिति यत् तत्र घातयुतित्रयम् ।
कर्णद्वयेषु द्वन्द्वानामेतद् घातत्रयं भवेत् ॥ ६१७ ॥

व्याख्या—1. A. C. द्वयया तु

2. C. Hapl. om. after ययोः upto ययोः, three lines below.

यस्तत्राद्यान्त्ययोर्घातः श्रुत्योश्चाद्यद्वितीययोः ।
तयोर्द्वयोश्च संवर्गाद् द्वितीयान्त्यवधेन यत् ॥ ६१८ ॥

विभज्य लभ्यते सा स्यादाद्यकर्णकृतिस्तथा ।
द्वितीयकर्णवर्गोऽपि भवेतां वोःश्रुती ततः ॥ ६१९ ॥

[iv. व्यासार्धमन्तरा ज्यानयनम्]

न्यायेनानेन चार्धज्याः सर्वा अपि नयेद्यथा ।
तत्तज्ज्यावर्गमाद्यज्यावर्गहीनं हरेत् पुनः ॥ ६२० ॥

आसन्नाधःस्थशिञ्जिन्या लब्धा स्यादुत्तरोत्तरा ।
इत्थं साध्याः गुणाः सर्वे व्यासार्धनिरपेक्षकाः ॥ ६२१ ॥

इति ।

कृत्स्नज्यार्धद्वितीयज्यावर्गयोर्लम्बजां कृतिम् ।
त्यक्त्वा तन्मूलयोर्योगस्तृतीयज्या भवेत् ततः ॥ ६२२ ॥

अन्तरं प्रथमज्या स्यादिति प्रागेव दर्शितम् ।
अनेन विधिना कर्णोऽप्यानेतव्यश्चतुर्भुजे ॥ ६२३ ॥

चतुर्थधनुरग्रान्तात् तृतीयधनुरग्रतः ।
समस्तज्याऽथ तन्मध्यभेदि व्यासदलं नयेत् ॥ ६२४ ॥

तृतीयधनुरग्रान्तं कृत्स्नज्यार्धभुजा ततः ।
तत्कोटिका च व्यासार्धं तत्कृत्स्नज्याशरोनितम् ॥ ६२५ ॥

या स्यात् प्रागपरा सूत्राद् द्वितीयधनुरग्रगा ।
सा भुजा तच्छरोनं च व्यासार्धं कोटिका परा ॥ ६२६ ॥

ताभिश्चतसृभिः क्षेत्रं भवेद् भिन्नचतुर्भुजम् ।
केन्द्राद् द्वितीयज्याग्रान्तः कर्ण एकोऽपरः पुनः ॥ ६२७ ॥

कृत्स्नज्यामध्यतो वेद्यो द्वितीयगुणमूलकः[1] ।
कृत्स्नज्यार्धद्वितीयज्याभुजयोर्मूनिरेव सा[2] ॥ ६२८ ॥

व्याख्या—1. A. मूलतः; C. मूलगः 2. B. सः

तृतीयगुणतुल्यत्वं तस्य प्रागेव दर्शितम् ।
मिथः[1] कोटिघ्नयोर्योगात् स तु कर्णांशकस्तयोः ॥ ६२९ ॥

भुजप्रतिभुजाभ्यासयोगस्तत्कर्णयोर्वधः ।
कल्पितेनात्र हारेण भागहारे हृते सति ॥ ६३० ॥

हारोऽन्यस्तत्फलं चापि स्यातां भाज्यस्य हारकौ ।
कयोश्चिदथ संवर्गो हाराभ्यां ह्रियते यदा ॥ ६३१ ॥

तदा गुणावुभौ हार्यौ हाराभ्यां पृथगेव तौ ।
तयोर्घातः पुनः कार्यः फलसाम्यात्तु सर्वदा ॥ ६३२ ॥

हारेण न पुनर्हार्यं केवलस्य स्फुटत्वतः ।
अपवर्तितयोर्बाह्वोर्यद्वा घातेऽपि वर्गिते ॥ ६३३ ॥

तयोः केवलयोर्बाह्वोर्वर्गाभ्यां शोधिते सति ।
पृथक् तयोर्मूलयुतिर्द्वितीयः कर्ण इष्यते ॥ ६३४ ॥

यासौ भुजप्रतिभुजासंवर्गद्वयसंयुतिः ।
कर्णसंवर्गतुल्यत्वं तस्याः सम्यङ् निरूपितम् ॥ ६३५ ॥

तदायतचतुर्बाहौ तथा समचतुर्भुजे ।
क्षेत्रे तु संववत्येव तथा भिन्नचतुर्भुजे ॥ ६३६ ॥

द्वयोर्द्वयोर्भुजाकोटिस्वरूपं[2] नान्ययोर्द्वयोः[3] ।
यत्रैकः कर्णसंवर्गः स्याद् दोःकोट्योर्वर्गयोगतः ॥ ६३७ ॥

[4]नाप्यन्यकर्णस्तद्वेद्यं नापि[5] भिन्नचतुर्भुजम् ।
चतुर्णामपि बाहूनां नास्ति दोःकोटिरूपता ॥ ६३८ ॥

यस्मिन् नियतकं चैतत् क्षेत्रं[6] तत्राप्यसौ पुनः ।
भुजप्रतिभुजाभ्यासयुतिः कर्णवधो भवेत् ॥ ६३९ ॥

व्याख्या—1. C. मथ
2. B. कोटिरूपत्वं
3. B. C. नान्ययोरपि
4. C. om. the line.
5. B. om. नापि
6. A. B. च क्षेत्रं

विप्रकृष्टं परं कोणचतुष्कं वृत्तकेन्द्रतः ।
अन्याचृक्क्षेत्रफलतः फलं यत्राधिकं भवेत् ॥ ६४० ॥

यत्र कोणचतुष्कं च वृत्तनेम्याश्रितं भवेत् ।
चतुर्भुजं तन्नियतकर्णक्षेत्रमुदीरितम् ॥ ६४१ ॥

आद्यबाह्वोर्द्वितीयाद्यास्तत्र प्रतिभुजाह्वयाः ।
अतो भुजप्रतिभुजघातयोगास्त्रयो मताः ॥ ६४ ॥

कर्णद्वितयसंवर्गास्त्रय एव भवन्त्यतः ।
आद्यद्वितीययोर्घातो यस्तथाऽऽद्यतृतीययोः ॥ ६४३ ॥

तद्घातो ह्रियते घाते च द्वितीयतृतीययोः ।
लब्धः प्रथमकर्णस्य वर्गो भवति स स्फुटम् ॥ ६४४ ॥

कर्णवर्गद्वयं चान्यन्नीयते विधिनामुना ।
हारः स हार्यस्तं गृहीतभुजप्रतिभुजावधः ॥ ६४५ ॥

[वृत्तान्तर्गतचतुरश्रक्षेत्रफलद्वारा व्यासानयनम्]

न्यायेनानेन चतुरश्रयोर्भिः परिधिं विना ।
व्यासानयनसिद्ध्यर्थं फलानयनमुच्यते ॥ ६४६ ॥

[1]चतुर्भुजं यद्विषमं वृत्तान्तर्भागसंस्थितम् ।
तन्नेमिस्पृष्टतत्कोणः कर्णस्तत्र भवेद् यथा ॥ ६४७ ॥

तत्कर्णभूमितत्पार्श्वभुजाद्वितयबोर्युगम् ।
त्रिभुजद्वितयं कल्प्यं तस्य कर्णस्य पार्श्वगम् ॥ ६४८ ॥

तल्लम्बद्वययोगघ्नं भूम्यर्धं स्यात् फलं स्फुटम् ।
चतुर्भुजान्तस्तयोस्त्रिभुजक्षेत्रयोर्भुवि ॥ ६४९ ॥

लम्बद्वयस्पृग्विवरं यत्तल्लम्बान्तरं मतम् ।
[2]अस्य वर्गयुताल्लम्बयोगवर्गात् पदं तु यत् ॥ ६५० ॥

व्याख्या—1. Verse 647-48 are the same as verses 1 and 5 of the *Kriyākramakarī* on *Līlāvatī*, 188-90, (Edn., pp. 351-52).

2. A. B. मन्यवर्ग

स स्याद् द्वितीयकर्णोऽतो द्वितीयश्रुतिवर्गतः ।
लम्बान्तरकृतित्यागाल्लम्बयोगकृतिर्भवेत् ॥ ६५१ ॥

लम्बान्तरं त्वेकदिग्गताबाधाद्वितयान्तरम् ।
भूमध्याल्लम्बमूलस्पर्शस्य भूमौ यदन्तरम् ॥ ६५२ ॥

स्वाबाधयोरन्तरस्य दलं तद्यत्पुनः परम् ।
आबाधयोरन्यलम्बसम्बन्ध्योरन्तरा दलम्[1] ॥ ६५३ ॥

[2][तयोर्योगोऽन्तरं] वा स्याल्लम्बयोर्विवरं भुवि ।
यत्र भूमध्यतस्तूभयतो लम्बद्वयं पतेत् ॥ ६५४ ॥

तत्र योगोऽन्यथा भेदः स्याल्लम्बद्वितयान्तरम् ।
लम्बद्वयैकदिश्याबाधयोरप्यन्तरं च तत् ॥ ६५५ ॥

भूमध्याल्लघुदोर्भागे लम्बमूलं पतेद् भुवि ।
अतो लघुभुजायुग्मं कर्णकाग्रं स्पृशेद्यदि ॥ ६५६ ॥

भूमध्यादेकपार्श्वे तत् तर्हि लम्बद्वयं पतेत् ।
भूमध्याल्लम्बपार्श्वे लम्बपातस्त्वन्यथा भवेत् ॥ ६५७ ॥

भुजावर्गान्तराद् भूम्युद्धृतमाबाधयोर्भिदा ।
तद्दलं लम्बमूलाद् भूमध्यान्तरमुदाहृतम् ॥ ६५८ ॥

भुजावर्गान्तरार्धा भूम्युद्धृतं तद् भवेत् ततः ।
ततस्तदिष्टकर्णस्य पृथक् पार्श्वद्वयोत्थयोः ॥ ६५९ ॥

दोष्णोर्वर्गान्तरार्धे ये तद्योगादथवान्तरात् ।
भुवा विभज्य लब्धध्यं लम्बपातद्वयान्तरम् ॥ ६६० ॥

तत्र तावद् द्वयो राश्योर्भेदेऽन्यद्द्वितयान्तरम् ।
क्षिप्येत यदि तत्राद्यराश्योर्यस्तु महान् भवेत् ॥ ६६१ ॥

यश्चान्ययोस्तद्युतितः स्वल्पद्वययुतिं त्यजेत् ।
स्यादन्तरद्वययुतिरथ यत्रान्तरान्तरम् ॥ ६६२ ॥

व्याख्या—1. A. रन्तराद् दलम् 2. Mss. read तयोर्योगान्तरा वा

कार्यं तत्राल्पमहतोर्योगावन्ययुतिं त्यजेत् ।
शिष्टं द्वयोरन्तरयोरन्तरं स्यादितीरितम् ॥ ६६३ ॥

"अन्तरयोगे कार्ये राशिद्वयायो[1]र्महद्युतेस्त्याज्या ।
इतरयुतिरन्तरे चेन्न्यूनाधिकयोगतोऽन्ययुतिः" ॥ ६६४ ॥

यत्रेष्टकर्णमूले वा तदग्रे वा महाभुजे ।
संयुते तत्र महतोर्भुजयोर्वर्गयोगतः[2] ॥ ६६५ ॥

त्याज्योऽन्यकृतियोगोऽतः प्रतिदोर्गतयोगतः ।
संयुज्येते तदा ह्यधद्वयोस्थमहदल्पयोः ॥ ६६६ ॥

दोर्वर्गयोगः कार्योऽतः प्रतिदोर्वर्गयोगतः ।
प्रतिदोर्वर्गयोगोनाद् दलं यत्तत् समीहितम् ॥ ६६७ ॥

यत्रैकभवयोर्दोष्णोर्महती कर्णमूलगा ।
[3]तदग्रगान्योस्थमहाभुजा तत्र महद्युतेः[4] ॥ ६६८ ॥

यतस्त्याज्योऽल्पयोगतः प्रतिदोर्वर्गयोगतः ।
इतरप्रतिदोर्वर्गयोगोनार्धमिहापि तत् ॥ ६६९ ॥

तदेव प्रतिदोर्वर्गयोगार्धद्वितयान्तरम् ।
सर्वत्रातः प्रतिभुजावर्गयोगदलान्तरात् ॥ ६७० ॥

इष्टकर्णोद्धृतं भूम्यां लम्बपातद्वयान्तरम् ।
प्रतिदोर्वर्गयोगार्धविवरस्य कृतेस्ततः[5] ॥ ६७१ ॥

यदीष्टकर्णवर्गाप्ता सा लम्बान्तरभुजाकृतिः ।
लम्बान्तरकृतित्यागादितरश्रुतिवर्गतः ॥ ६७२ ॥

लम्बयोगकृतिः स्यादित्यपि वेद्यं यथोदितम् ॥ ६७२ ॥

"आबाधयोरेककुप्स्थयोर्यत्स्यादन्तरं तत्कृतिसंयुतस्य ।
लम्बैक्यवर्गस्य पदं द्वितीयकर्णो भवेदि"त्यत एव सिद्धम् ॥ ६७३ ॥

(लीलावती, १८१)

व्याख्या—1. A. द्वयतो   2. A. C. योगग:

3. A. उदग्र   4. B. महद्युते

5. C. कृतेऽस्तु ते

लम्बैक्यवर्गगुणिताविष्टकर्णस्य वर्गतः ।
तुर्यांशश्चतुरश्रक्षेत्रफलस्य कृतिर्भवेत् ॥ ६७८ ॥

यतो लम्बगुणं[1] भूमेर्दलं त्र्यश्रफलं[2] भवेत् ।
त्र्यश्रद्वयोत्थफलयुक् चतुर्भुजफलं भवेत् ॥ ६७५ ॥

यतश्चतुर्भुजस्यास्य भवेत् त्र्यश्रद्वयात्मता[3] ।
यत्रेष्टकर्णवर्गघ्नादितरश्रुतिवर्गतः ॥ ६७६ ॥

त्यज्येत लम्बान्तरजा[4] कृतिः साप्यत्र हन्यताम् ।
वर्गेणेष्टश्रुतेर्यस्मात् कार्या सच्छेदतानयोः ॥ ६७७ ॥

अतो लम्बान्तरकृतिं चान्यकर्णकृतिं पृथक् ।
हत्वेष्टकर्णवर्गेण फलवर्गस्तदन्तरम् ॥ ६७८ ॥

द्विगुणोऽयमतोऽस्माच्चतुरंशो यः स केवलः ।
फलवर्गो यतो भूम्यर्धघ्नो लम्बः फलं भवेत् ॥ ६७९ ॥

इष्टकर्णकृतिर्हारो यत्तदर्धकृतिर्गुणः ।
चतुर्घ्नतुर्यो वर्गो यद् द्विगुणार्धस्वमूलयोः ॥ ६८० ॥

अतः प्रतिभुजार्धद्वितयकृत्यन्वयात् पदम् ।
तादृशं कृतियोगं त्यक्त्वा तच्छिष्टकृतिं त्यजेत् ।
कर्णघातार्धवर्गः स्यात् फलवर्गो यथोदितम् ॥ ६८१ ॥

"प्रतिभुजदलकृतियुत्योर्यदन्तरं यच्च कर्णघातदलम् ।
वर्गान्तरपदमनयोश्चतुर्भुजे क्षेत्रफलमधिकम्" ॥ ६८२ ॥

इति ।

कर्णाग्रश्रितयोर्दोष्णोर्घातोन्याहतिसंयुतः ।
तथान्यकर्ण[5]सम्बन्धि प्रतिदोर्घातयुक् परः ॥ ६८३ ॥

आद्यौ गुण्यौ क्रमाद् व्यस्तं तौ हारौ गुणकोऽपरः ।
लब्धावाद्यद्वितीयौ स्तां पृथक्कर्णावितीरितम् ॥ ६८४ ॥

व्याख्या—1. A. लम्बान्तरं (wr.); C. लम्बाणां
2. A. C. तत् त्रिफलं   3. A. द्वयोत्थता
4. B. लम्बान्तरजः   5. A. B. खण्ड for कर्ण

इत्युक्तन्यायतः कर्णसंवर्गो यदि वीयते ।
गुणघ्नाद् गुण्यघातात् स हारघातेन लभ्यते ॥ ६८५ ॥

अत्राद्यराश्योर्घातो यः सैव गुण्याहतिर्यतः ।
स एव हारघातोऽतस्तुल्यत्वान्नष्टयोर्द्वयोः ॥ ६८६ ॥

लभ्यते गुण एवातः फलत्वेन ततः स्थितम् ।
प्रतिबोर्घातयोगो यः सः स्यात्कर्णाहतिस्त्विति ॥ ६८७ ॥

तद्वर्गवर्गतस्त्याज्यमिष्टकर्णार्धसंगुणम्[1] ।
लम्बपातान्तरकृति शिष्टं फलकृतिर्भवेत् ॥ ६८८ ॥

इह प्रतिभुजावर्गयोगयोर्भवतो वलम् ।
इष्टकर्णेन हार्यं भूयो गुण्यं तत्फलेन तम्[2] ॥ ६८९ ॥

यतोऽतः प्रतिबोर्वर्गयोगद्वितयतुर्ययोः ।
या भिदा सैव नेयात्र ततः प्रतिभुजार्धयोः ॥ ६९० ॥

वर्गयोगद्वितययोरन्तरेणापि लभ्यते ।
यतो यत्कृतितुल्यांशः स तद्दलकृतेः समः ॥ ६९१ ॥

घातार्धतुल्यो वलयोर्घातो द्विगुणितो यतः ।
अतो घातो द्विगुणितो प्रतिबोर्वलयोः पृथक् ॥ ६९२ ॥

यो तयोः संयुतेस्तुल्यं कर्णघातवलं मतम् ।
योगभेदार्द्धयोरेको राशिः सोऽतः परः पुनः ॥ ३९३ ॥

प्रतिबोरर्धवर्गद्वितययोगद्वयान्तरम् ।
तौ द्वौ राशी ययोर्योगान्तरघातात्[3] फलं भवेत् ॥ ६९४ ॥

यद्वान्तरं तयोर्योगश्चेत्थमत्र निरूप्यताम् ।
भूमुखार्धहतौ द्विघ्न्यां युञ्ज्यात् कृतियुतं तयोः ॥ ६९५ ॥

अन्यद्द्वोरर्धघाताद् द्विघ्नात् तत्कृतियुतिं त्यजेत् ।
तयोर्योगस्तु योगान्तरयोरन्यतरो भवेत् ॥ ६९६ ॥

व्याख्या—1. C. संगुण: 2. A. C. तदल्पेन तत्

3. C. Hapl. om. after घातात् to घातात् in the third line below.

पार्श्वयोर्वलघाते द्विघ्ने तत्कृतियुतिं[1] क्षिपेत् ।
भूमुखार्धहते द्विघ्न्यास्त्याज्यं स्यात् तत्कृतिद्वयम् ॥ ६९७ ॥

तयोर्योगश्च योगान्तरयोरन्यतरो भवेत् ।
वर्गयोगो द्वयो राश्योर्द्विघ्नघातेन संयुतः ॥ ६९८ ॥

हीनो वा तत्पदे राश्योर्योगभेदौ यतस्ततः ।
[2]उक्ता यत्कृतियुत्यूनद्विघ्नघातस्य योज्यता ॥ ६९९ ॥

तदाधिक्यात् कृतियुतेस्ततः शिष्टमृणं मतम् ।
[3]अतो भूमुखयोरर्धयोगवर्गाद्यदान्ययोः ॥ ७०० ॥

दोष्णोरर्धान्तरकृतिस्त्यक्तव्या स्यात् तदा द्वयोः ।
वर्गात्मकत्वात् तद् भेदो राश्योर्वर्गान्तरं मतम् ॥ ७०१ ॥

भूमुखार्धयुतौ तस्मात् पृथक् पार्श्वार्धदोर्भिदाम् ।
क्षिपेत् त्यजेच्च तौ राशी स्यातां योगान्तरात्मकौ ॥ ७०२ ॥

पार्श्वयोरर्धविवरं योज्यं यत्रोक्तयुक्तितः ।
महद्युतिस्वल्पभेदात् तत्र सिद्धयेच्च तद्युतम् ॥ ७०३ ॥

कार्यान्तरवियोगेऽत्र स्वल्पं योज्यं महत् त्यजेत् ।
तदन्तरवियुक्तं स्यादथवेत्थं नयेदिमौ ७०४ ॥

सर्वदोर्बलयोगात् तत्कृत्स्नं पार्श्वभुजां कृशाम् ।
त्यजेत् पृथक्स्थान्महतीं चात्र शिष्टौ क्रमादिमौ ॥ ७०५ ॥

एवं पार्श्वस्थदोरर्धयोगादर्धाद् भिदा कृतिम् ।
मुखभूम्यर्धयोस्त्याज्या यदत्राप्येवमूह्यताम् ॥ ७०६ ॥

सर्वदोर्वलयोगात्तन्मुखं त्याज्यं पृथङ् महीम् ।
तौ द्वौ चतुर्णां घातः स्यात् फलवर्गो यथोदितम् ॥ ७०७ ॥

"सर्वदोर्युतिदलं चतुःस्थितं बाहुभिर्विरहितं च तद्युतेः ।
मूलितं नियतकर्णके फलं स्पष्टमेवमुदितं त्रिबाहुके" ॥ ७०८ ॥

(लीलावती, १६६)

इति ।

व्याख्या — 1. A. तत्कृतिं 2. C. उक्तयत्कृति
3. A. भवो

कर्णत्रयाहृतिवलाद् व्यासेनाप्येतवाप्यते ।
यदुक्तं "कर्णयोर्घाताद् व्यासाप्तो लम्ब" इत्यसौ ॥ ७०९ ॥

लम्बयोगसमोऽतोऽयमन्यकर्ण[1]बलाहृतः ।
चतुर्भुजक्षेत्रफलं भवतीत्युपपद्यते । ७१० ॥

कर्णत्रयाहृतिवलात् फलाप्तं व्यास इत्यपि ।
तत एव च कर्णत्रितयवर्गसमाहृते ॥ ७११ ॥

फलकृत्या चतुर्घ्न्याप्तं यत् सा व्यासकृतिर्भवेत् ।
षोडशघ्नी फलकृतिर्यत्तया तूक्तघाततः ॥ ७१२ ॥

भवेद् व्यासार्धवर्गश्चेत्युपपन्नं यथोचितम् ।
दोष्णां द्वयोर्द्वयोर्घातयुतीनां तिसृणां वधे[2] ॥ ७१३ ॥

एकैकोनेतरत्र्यैक्यचतुष्के वधभाजिते ।
लब्धमूलेन यद्वृत्तं विष्कम्भार्धेन निर्मितम् ॥ ७१४ ॥

सर्वं चतुर्भुजं क्षेत्रं तस्मिन्नेवावतिष्ठते ।
यत्सर्वतोर्युतिदलमेकैकभुजवर्जितम् ॥ ७१५ ॥

द्विगुणेनामुना तुल्यमेकैकोनेतरत्रियुक् ।
तद्घातः षोडशगुणं फलवर्गो भवेद् यतः ॥ ७१६ ॥

चतुष्कस्थो द्विगुणितः षोडशघ्नो भवेदतः ।
कर्णकृत्या हतेस्तेनाऽऽप्यते व्यासार्धजा कृतिः ॥ ७१७ ॥

जीवाभिरेव तद्व्याससिद्धिरेवमुदीरितम् ॥ ७१८ ॥

[वृत्तान्तर्गतचतुरश्रफलन्यायस्य त्र्यश्रक्षेत्रफले अतिदेशः]

चतुरश्रफलन्यायस्त्र्यश्रक्षेत्रेऽतिदिश्यते ।
यत्सर्वदोर्युतिदलं चतुर्धा परिकल्पितम् ॥ ७१९ ॥

तदिदं कर्णयोगार्धं भूम्यर्धेन च संयुतम् ।
तत्र भूमिविहीनं यद् यच्च केनाप्यनूनितम् ७२० ॥

व्याख्या—1. C. Hapl. om. after कर्ण to कर्ण in the second line below.

2. C. लये for वधे

भूम्यर्धयुक्तहीने द्वे[1] कर्णयोगदले उभे ।
लम्बवर्गसम: प्रायस्तयो: संवर्ग इष्यते ।। ७२१ ।।

राश्योर्योगान्तराभ्यासो यतो वर्गान्तरं मतम् ।
यत्संवर्गयोर्युतिदलं भुजाभ्यां रहितं क्रमात् ।। ७२२ ।।

भुजान्तरार्धयुक्तोनं भूम्यर्धद्वितयं हि तत् ।
ततस्तयोर्द्वयोर्घातो हीनो भूम्यर्धवर्गत: ।। ७२३ ।।

भुजान्तरार्धवर्गेणेत्येतद् वर्गे प्रदर्शितम् ।
"इष्टोनयुग्राशिवध: कृति"रित्युदितं यत: ।। ७२४ ।।

आबाधाभुजयोर्वर्गान्तरं लम्बकृतिर्यत: ।
भुजयोर्वर्गयोगार्धादाबाधावर्गयोर्दले[2] ।। ७२५ ।।

विशुद्धे लम्बवर्गोऽत्र शिष्यते त्रिभुजे यत: ।
भुजयोगार्धवर्गादत्राबाधायोगयोर्दले ।। ७२६ ।।

वर्गीकृत्य विशुद्धेऽस्मिन् अधिकं लम्बवर्गत: ।
बाह्वोराबाधयोश्चान्तरार्धयोर्वर्गभेदत: ।। ७२७ ।।

तथाहि वर्गयोगार्धे घाते भेदकृतेर्दलम् ।
योगार्धवर्गे तु तयोर्घातस्तद्भेदवर्गत: ।। ७२८ ।।

तुर्यांशश्च स्थित: सोंऽशोऽप्यन्तरार्धकृते: सम: ।
योगार्धवर्गतस्तस्माद् वर्गयोगदलस्य तु ।। ७२९ ।।

आधिक्यमन्तरार्धस्य वर्गेण स्यादिति स्थितम् ।
योगार्धवर्गे भुजयोस्तथैवाऽबाधयोरपि ।। ७३० ।।

स्वस्वभेदार्धवर्गेण न्यूनत्वं यत्पुनर्द्वयो: ।
आबाधयोरन्तरार्धवर्गस्तत्राधिकोऽन्यत: ।। ७३१ ।।

स शोध्यराशेर्न्यूनोंशऽस्त्यक्तेऽन्यत्रावशिष्यते ।
न्यूनोंऽश:[3] शोध्यराशिस्थ: शुद्धराशौ तु शिष्यते ।। ७३२ ।।

व्याख्या—1. C. ते for द्वे 2. Mss. read योगतो बले
3. A. C. न्यूनांश:

योगार्धवर्गे भुजयोर्वर्गो भेददलस्य यः ।
स न्यूनोंऽशोऽन्तरार्धस्य वर्गाबाबाधयोस्ततः ॥ ७३३ ॥

त्यक्तेऽस्मिन् लम्बवर्गे तु स एवांशोऽतिरिच्यते ।
योगार्धयोर्यो नियमः स स्याद् भेदार्धयोरपि ॥ ७३४ ॥

तादृक् तद्वर्गयोस्तस्मात् तद्वर्गान्तरयोरपि ।
योगार्धयोर्वर्गभेदात् ततस्तद्भुजयोर्हृतात्[1] ॥ ७३५ ॥

अन्तरार्धस्य वर्गेण भक्त आबाधयोर्द्वयोः ।
योगार्धकृत्या भेदार्धवर्गभेदोऽत्र लभ्यते ॥ ७३६ ॥

स एव लम्बवर्गेऽस्मिन्नधिकोंऽशो यतस्ततः ।
ताभ्यां च गुणहाराभ्यां लब्धं भूम्यर्धवर्गतः ॥ ७३७ ॥

शोध्यं ततो भुजाभेददलवर्गसमं च तत् ।
भुजान्तरार्धवर्गघ्नाद् यतो भूम्यर्धवर्गतः ॥ ७३८ ॥

आबाधयोर्योगदलवर्गाप्तः स्वगुणो भवेत् ।
भूमध्यवर्गो ह्याबाधायोगार्धस्य[2] कृतिर्यतः ॥ ७३९ ॥

गुणहारकयोः साम्ये गुण एव फलं यथा ।
तत्सवंबोर्युतिदलद्वये बाहुद्वयोनिते ॥ ७४० ॥

तयोर्द्वयोस्तु संवर्गस्तत्र लब्धफलोनितः ।
भूम्यर्धवर्गो भवतीत्येव लब्धफलोनितः ॥ ७४१ ॥

योगार्धयोर्वर्गभेदहतो वर्गः फलोद्भवः ।
तन्मूलं त्रिभुजक्षेत्रफलं भवति सुस्फुटम् ॥ ७४२ ॥

इति ।

[शरानयनम्]

वृत्ते वृत्तान्तरग्रस्ते सति[3] न्यायोऽयमूह्यताम् ।
वृत्तकेन्द्रद्वयस्पृष्टो व्यास एको भवेत् तयोः ॥ ७४३ ॥

व्याख्या—1. C. कृतात् 2. Mss. read योर्थस्य
3. A. स हि ; C. समि

साधारणी समस्तज्या तत्सम्पातान्तरोद्भवा ।
कृत्स्नज्यामध्यगौ व्यासे शरौ वृत्तद्वयोद्भवौ ॥ ७४४ ॥

तत्राल्पवृत्तस्य शरो महानन्यस्य चाल्पकः ।
शरोनव्यासशरयोर्घातस्तुल्यस्तयोर्भवेत् ॥ ७४५ ॥

समस्तज्यार्धवर्गस्य तुल्यत्वादुभयोरपि ।
शरोनव्यासयोर्यादृङ्नियमो महदल्पयोः ॥ ७४६ ॥

तादृशो नियमो वेद्यः शरयोर्महदल्पयोः ।
व्यासयोर्नियमस्तादृक् शर[1]द्वयविहीनयोः ॥ ७४७ ॥

शरद्वयोनितौ व्यासौ शरवर्गहृतौ पुनः ।
शरद्वयोनितव्यासयोगभक्तौ शरौ ततः ।
एष एव विधिः सम्यगाचार्येण प्रदर्शितः ॥ ७४८ ॥

"ग्रासोने द्वे वृत्ते ग्रासगुणे भाजयेत् पृथक्त्वेन ।
ग्रासोनयोगलब्धौ सम्पातशरौ परस्परतः" ॥ ७४९ ॥

(आर्यभटीयम्, गणित० १८)

इति ।

[गोलपृष्ठक्षेत्रफलम्]

वृत्तव्यास-धनु-र्बाण-जीवा-न्यायं सविस्तरम् ।
इत्थं प्रोच्याथ तत्साम्याद् घनगोलफलं ब्रुवे ॥ ७५० ॥

यज्ज्ञातवृत्तव्यासाभ्यां तदन्यदनुपाततः ।
सिद्ध्येत् खण्डान्तरयुतिः पिण्डज्यायोगतश्च यत् ॥ ७५१ ॥

ततस्तन्न्यायतः सिद्ध्येद् गोलस्यान्तर्बहिःफलम् ।
[2]तुल्यचापान्तरे मध्यात् पार्श्वयोरुभयोरपि ॥ ७५२ ॥

व्याख्या—1. A. C. तादृक् करे

2. Verses 752b-94 are the same as verses 1-44 of the *Kriya-kramakarī*, on the *Līlāvatī*, 201-03, (Edn., pp. 395-99).

गोलपृष्ठं तथा छिन्द्यात् परिध्यंशो यथा समः ।
चापभागान्तरेखास्तु तुल्यान्तरायता यत:[1] ॥ ७५३ ॥

रेखान्तरालविस्तारं रेखामध्यसमायतम् ।
ऋजूकृतं यथा क्षेत्रं समलम्बं चतुर्भुजम् ॥ ७५४ ॥

रेखाऽऽस्य महती भूमि: स्वल्पा च मुखमिष्यते ।
रेखान्तरालं लम्बोऽस्य चापभागसमो भवेत् ॥ ७५५ ॥

मुखातिरिक्तं तद्भागमादायाऽऽस्यैकपार्श्वत: ।
तत्पार्श्वेऽन्यत्र तु व्यस्तन्यस्ते दीर्घचतुर्भुजम् ॥ ७५६ ॥

रेखान्तरालविस्तारं रेखामध्यायतं भवेत् ।
आयामविस्ताराभ्यासो गोलपृष्ठफलं भवेत् ॥ ७५७ ॥

घनानपेक्षं सर्वत्र फलं समचतुर्भुजम् ।
तदर्थमर्धजीवानां व्यासार्धत्वप्रकल्पनात् ॥ ७५८ ॥

तत्तत्परिधयो नेया: क्षेत्रायामप्रसिद्धये ।
तत्तत्पिण्डगुणात् कृत्स्नज्यावर्गनिहताद् यथा ॥ ७५९ ॥

त्रिज्यावर्गेण विहृतं[2] तत्तत्खण्डान्तरं भवेत् ।
तत्तत्खण्डान्तरात्तद्वत् त्रिज्यावर्गसमाहतात् ॥ ७६० ॥

कृत्स्नज्यावर्गविहृता: पिण्डज्या: प्रातिलोम्यत: ।
तद्वत् खण्डान्तरयुते: पिण्डज्यायुतिराप्यते ॥ ७६१ ॥

सा गोलपरिधिक्षुण्णा व्यासार्धेन च संहृता ।
लब्ध: परिधियोग: स्याच्चापखण्डहत: स च ॥ ७६२ ॥

फलं गोलैकपार्श्वस्थं द्विघ्नं कृत्स्नफलं भवेत् ।
अत्र खण्डान्तरयुति: प्रायश्चापं प्रकल्प्यते ॥ ७६३ ॥

स त्वाद्यो गुणकार: स्याच्चापभागस्तथान्तिम: ।
हार: समस्तज्यावर्ग[3]स्तुल्यत्वादुभयोस्तत: ॥ ७६४ ॥

व्याख्या—1. A. om. यत: 2. A. B. निहतं
3. A. B. C. वर्ग

चापवर्गेण गुणनं विधूय हरणं तथा ।
व्यासार्धवर्गगुणने तेनैव हरणे पुनः ॥ ७६५ ॥

गुणनं केवलेनैव व्यासार्धेन विधीयते ।
परिधेर्द्विगुणत्वार्थं व्यासेन गुणनं मतम् ॥ ७६६ ॥

जिज्ञासितफलं गोलं घनसाम्येन खण्डयेत् ।
यथा दर्पणवृत्ताभाः खण्डा नानाप्रमाणकाः ॥ ७६७ ॥

तेषां व्यासार्धनिहतं परिध्यर्धं फलं भवेत् ।
वृत्तक्षेत्रे द्विधा भक्ते पार्श्वयोरुभयोस्ततः ॥ ७६८ ॥

खण्डाः केन्द्रस्थतीक्ष्णाग्रा नेमिस्थस्थूलमूलकाः ।
ऋजूकृत्य तयोर्योगे तदायतचतुर्भुजम् ॥ ७६९ ॥

तीक्ष्णाग्रसूचीकान्योन्यविवरं निबिडं[1] भवेत् ।
परिध्यर्धं यदायामो व्यासार्धं चापि विस्तृतिः ॥ ७७० ॥

अतो व्यासार्धनिहतं परिध्यर्धं फलं भवेत् ।
तद्गोलव्यासनिहतं ज्ञातव्यासहृतं फलम् ॥ ७७१ ॥

व्यासोऽत्र गोलमध्यस्थो विदितो नापरस्ततः ।
व्यासार्धान्यान्यखण्डानामानेयानि पृथक् पृथक् ॥ ७७२ ॥

तत्तद्व्यासार्धतो गोलपरिधिघ्नात् ततो हृतम् ।
गोलव्यासेन सर्वेषां परिध्यर्धमवाप्यते ॥ ७७३ ॥

स्वव्यासार्धहते तस्मिन् वृत्तकेन्द्रफलं भवेत् ।
तत्तद्व्यासार्धवर्गेण गोलस्य परिधिर्हतम् ॥ ७७४ ॥

गोलव्यासेन विहृतं तत्तत्क्षेत्रफलं भवेत् ।
फलं समुदितं तेषां गोलक्षेत्रफलं भवेत् ॥ ७७५ ॥

व्यासार्धवर्गाः खण्डानामर्धज्यावर्गसम्मिताः ।
शरयोर्वर्गयोगोन कृत्स्नव्यासस्य या कृतिः ॥ ७७६ ॥

व्याख्या — 1. A. विविदं

वलिता शरसंवर्गतुल्यार्धज्याकृतिर्भवेत् ।
यावद्वा खण्डितो व्यासो गच्छे तत्खण्डसम्मिते ॥ ७७७ ॥

एकाद्येकोत्तराङ्कानां वर्गसङ्कलितं तु यत् ।
शरवर्गयुतिः केन्द्रस्यैकपार्श्वस्थिता भवेत् ॥ ७७८ ॥

सैव द्विगुणिता वेद्या वृत्तपार्श्वद्वयोत्थिता ।
[1]यः स्वल्पशरवर्गस्तत्रैकपार्श्वगतो भवेत् ॥ ७७९ ॥

स त्वन्यपार्श्वस्थमहाशरवर्गेण संयुतः[2] ।
शरयोरल्पमहतोर्वर्गयोगो भवेद् ध्रुवम् ॥ ७८० ॥

यावानल्पशरो व्यासस्तदूनस्तु महाशरः ।
शरयोरल्पमहतोर्योगो व्याससमो यतः ॥ ७८१ ॥

यावन्तोऽल्पशरास्तावन्तोऽन्यपार्श्वे महाशराः ।
वर्गयोगस्ततस्तेषां शरसंवर्गसम्मितः ॥ ७८२ ॥

वर्गयोगोनिते योगे वर्गघात[3]द्वयं भवेत् ।
यावद्वा खण्डितं वृत्तं व्यासवर्गाच्च तावता ॥ ७८३ ॥

गुणिताच्छरवर्गाणां त्याज्यं सङ्कलितं ततः ।
खण्डानां व्याससंख्यात्वात् तद्वर्गस्तद्गुणो घनः ॥ ७८४ ॥

व्यासस्य घनतस्तस्माद् वर्गसङ्कलितं त्यजेत् ।
शिष्टार्धमर्धजीवानां गोले वर्गयुतिर्भवेत् ॥ ७८५ ॥

सा गोलपरिधिक्षुण्णा गोलव्याससमुद्धृता[4] ।
लब्धं गोलफलं ज्ञेयमित्याहुर्गणकोत्तमाः ॥ ७८६ ॥

द्विघ्नी गच्छकृतिः सैकगच्छघ्नी षड्भिरुद्धृता ।
एकाद्येकोत्तराङ्कानां वर्गसङ्कलितं भवेत् ॥ ७८७ ॥

तत्र गच्छस्य सैकत्वमाद्याङ्कस्य जिघृक्षया ।
अत्यल्पत्वाद्विहाद्यस्य सैकत्वं न विधित्सितम् ॥ ७८८ ॥

व्याख्या—1. A. यत् स्वल्प 2. B. C. संयुतं

3. A. C. वर्गे घात

4. A. B. C. Hapl. om. of two lines after °द्धृता to °द्धृता. These lines have been restored from this verse occurring as *Kriyākramakarī* verse 35, (p. 398).

तत्र गच्छकृतिर्गच्छनिहता तद्घनो भवेत्[1] ।
छिन्नाद् घनाद् यः षष्ठांशो वर्गसङ्कलितं भवेत् ॥ ७८९ ॥

केवलश्चेद् घनत्र्यंशो वर्गसङ्कलि[तं ततः][2] ।
भवेत् पार्श्वद्वयापेक्षं छिन्नं त्र्यंशद्वयं तु तत् ॥ ७९० ॥

तस्मिन् व्यासघनात् त्यक्ते त्र्यंशो व्यासघनाद् भवेत् ।
एवंकृतो घनत्र्यंशो दलितोऽत्र विधीयते ॥ ७९१ ॥

शिष्टं घातद्वयं वर्गयोगोनाद् योगवर्गतः ।
स पुनः परिधिक्षुण्णो व्यासेन च विभज्यते ॥ ७९२ ।

तत्र व्यासेन गुणनं तेनैव हरणं तथा ।
त्यक्त्वोभयं[3] व्यासवर्गो गुण्यः परिधिनैव तु ॥ ७९३ ॥

षड्भिर्हृतं गोलघनफलं भवति सुस्फुटम् ।
अर्धज्यानां च सर्वेषां व्यासार्धत्वप्रकल्पनात् ॥ ७९४ ॥

तद्योगाद् गोलपरिधिक्षुण्णाद् व्यासदलोद्धृतम् ।
गोलक्षेत्रे क्षेत्रफलमित्याहुर्गणकोत्तमाः ॥ ७९५ ॥

['जीवे परस्पर'-न्यायेन ज्या-चापानयनम्]

यन्निजेतरकोटिघ्नजीवयोर्युतिभेदतः ।
त्रिज्याप्ते तद्धनुर्योगभेदज्ये स्तामितीरितम् ॥ ७९६ ॥

ज्याचापीकरणेऽप्येष विधिर्योज्यो मनीषिभिः ।
मिथः कोटिघ्नयोर्यद्वा त्रिज्याप्ता वा युतिर्भिदा ॥ ७९७ ॥

तच्चापान्तरजीवा स्यात्तच्चापिता धनुरन्तरम् ।
ज्याबाणवर्गयोर्योगे त्र्यंशं बाणकृतेः क्षिपेत् ॥ ७९८ ॥

तन्मूलं तद्धनुश्चैवमूनाधिकधनुर्नयेत् ।
अन्योन्यकोटिहतयोर्भेदादासन्नयोर्ज्ययोः[4] ॥ ७९९ ॥

व्याख्या—1. B. Hapl. om. after भवेत् to भवेत् , in the third line below.
2. Mss. तो for तं ततः
3. Mss. त्यक्तोभयं
4. A. B. सन्नयोर्ज्ययोः

शिष्टचापघनषष्ठभागतो
    विस्तरार्धकृतिभक्तवर्जितम् ॥
शिष्टचापमिह शिञ्जिनी भवेत्
    स्पष्टता भवति चाल्पतावशात् ॥ १७ ॥

[इष्टज्यानयनम्]

ऊनाधिकधनुर्ज्यां च नीत्वैवं पठितां न्यसेत् ॥ १८ ॥
ऊनाधिकधनुःकोटिजीवया तां समीपजाम् ।
निहत्य पठितां तस्याः कोट्या शिष्टगुणं च तम् ॥ १९ ॥
तद्योगं वाथ विश्लेषं हरेद् व्यासदलेन तु ।
इष्टज्या भवति, स्पष्टा तत्फलं स्यात् कलादिकम् ॥ २० ॥
न्यायेनानेन कोट्याश्च मौर्व्याः कार्या सुसूक्ष्मता ॥ २१a ॥

त्रिज्याप्तवर्गे तद्बाणवर्गं सत्र्यंशकं क्षिपेत् ।
तन्मूलमधऊर्ध्वस्थचापसन्धेर्धनुर्भवेत् ॥ ८०० ॥

तद्युक्तोनाधऊर्ध्वस्थचापसन्धिधनुर्धनुः ।
इति ज्याग्रहणोपायस्तच्चापीकरणे भवेत् ॥ ८०१ ॥

इति ॥

शिष्टचापेति (II. 17-21a)—

[इष्टज्यानयनम्]

इष्टचापसमस्तज्यावर्गाद् व्यासोद्धृतः शरः ।
व्यासेन हरणात् पूर्वं स तु व्यासाहतो भवेत् ॥ ८०२ ॥

अत एव शरस्यास्य वर्गस्तद्वर्गसम्मितः ।
कृत्स्नज्यावर्ग[वर्गस्त][1]च्छरवर्गे स्थिते सति ॥ ८०३ ॥

व्याख्या—1. A. B. om. वर्गस्त. B has a gap here.

[रविस्फुटः]

ज्यभ्यस्तबाहुकोटिभ्यां अशीत्याप्ते फले उभे ॥ २१b ॥
चापितं दोःफलं कार्यं स्वर्णं सूर्यस्य मध्यमे ।
केन्द्रोर्ध्वार्धे च पूर्वार्धे तत्कालार्कस्फुटः, स च ॥ २२ ॥

कृत्स्नव्यासस्य वर्गोऽपि हारकः परिकल्प्यते ।
चापार्धज्यान्तराप्तौ च तत्र्यंशोऽस्मिन्शिवकीर्तिते ॥ ८०४ ॥

कृत्स्नज्यावर्गवर्गोऽयं चतुर्घ्नो ह्रियते त्रिभिः ।
अथवा व्यासवर्गस्य चतुर्थोंऽशोऽत्र हारकः ॥ ८०५ ॥

स तु व्यासार्धवर्गः स्यात् स च त्रिघ्नोऽत्र हारकः ॥
वर्गाभ्यां गुणहाराभ्यामिह वर्गात्मकं फलम् ॥ ८०६ ॥

बाणवर्गात् कर्णकोट्योर्योगलब्धं तदन्तरम् ।
कर्णकोट्योर्योगदलमिष्टचापमिह स्मृतम् ॥ ८०७ ॥

तदीयमर्धकरणं हारके परिकल्पिते ।
इष्टचापं तथा त्रिज्यावर्गो द्विघ्नयोर्वधस्तथा[1] ॥ ८०८ ॥

कृत्स्नज्यावर्गवर्गस्य हारकाः स्युरमी त्रयः ।
इष्टचापोद्धृतः कृत्स्नज्यावर्गस्तद्धनस्त्विह ॥
ततः षड्भिर्हृता त्रिज्याकृत्या तद्धनु[2]रन्तरम् ॥ ८०९ ॥

इति ॥

ज्यभ्यस्तेति (II. 21b-23a)

[रविस्फुटः]

व्यस्तं गच्छति नीचोच्चपरिधौ[3] मध्यतः स्फुटः ।
दोःफलेन स पूर्वार्धे, पश्चार्धे गच्छति क्रमात् ॥ ८१० ॥

स्वर्णं तद्दोःफलं तस्मात् केन्द्रे जूकक्रियादिगे ।
कक्ष्यामण्डलनेमिस्थं वेद्यं मन्दफलं स्फुटम् ॥ ८११ ॥

व्याख्या—1. A. द्विघ्न्योस्तथा वधः 2. Mss. तत्तद्धनु
3. B, C. परिधा

मध्यसावनसिद्धोऽतः कार्यः स्यादुदये पुनः ॥ २३a ॥

[चरप्राणाः]

संस्कृतायनभागादेर्दोर्ज्या कार्या रवेस्ततः ॥ २३b ॥

चतुर्विंशतिभागज्याहतायास्त्रिज्यया हृतः ।
अपक्रमगुणोऽर्कस्य तात्कालिक इह स्फुटः ॥ २४ ॥

[चरप्राणवासना]

स्वदोःफलचापोद्वापसाध्यो मध्यात् स्फुटस्ततः ।
पश्चात् पुरोऽपि चोदेति सोऽर्कस्तद्भ्रमकालतः ॥ ८१२ ॥

तद्भोगोऽपि ततः कार्यस्तद्वन्मध्ये स्फुटेऽपि वा ।
भिन्ने रव्युदये प्राणकलान्तरचरासुभिः ॥ ८१३ ॥

तद्गतिः[1] भिन्न कर्तव्या तद्वत् तदवधौ ग्रहे ।
भगोलेन ग्रहो गच्छन् यदा यत्रैव दृश्यते ॥ ८१४ ॥

ततो दिनान्तरे दृश्यो दिनभोगकलान्तरे ।
स्वभोगलिप्तासहिताश्चक्र[2]लिप्तास्ततो दिने ॥ ८१५ ॥

भ्राम्यन्ति प्रत्यहं तत्र भोगकालो विभिद्यते ।
तत्कलाप्रतिबद्धानां राशीनां कालभेदतः ॥ ८१६ ॥

कालस्तु चक्रलिप्तानां भ्रमणे सर्वदा समः ।
प्रत्यहं सञ्चितो भोगः स यावान् गोलसन्धितः ॥ ८१७ ॥

कलात्मा तावतः कालाद् भेदः प्राणकलान्तरम् ।
अधिकाः स्युः कलागोलाद्यन्तयोः प्राणपिण्डतः ॥ ८१८ ॥

अयनाद्यन्तयोर्लिप्तापिण्डात् प्राणास्तथाधिकाः ।
अतो युग्मौजपदयोः स्वर्णं प्राणकलान्तरम् ॥ ८१९ ॥

उदेति क्षितिजस्थोऽर्कः प्राक्, पश्चादस्तमेति च ।
सौम्यगोलेऽथ, याम्येऽस्मिन् व्यस्तमस्तोदयौ ततः ॥ ८२० ॥

दक्षिणोत्तरवृत्तस्थं क्षितिजोन्मण्डलान्तरम् ।
अक्षज्या सा क्षितिज्या स्यादिष्टक्रान्तिप्रवेशजा ॥ ८२१ ॥

व्याख्या—1. A. तत्कृतिः; B. तद्···तिः 2. A. सहितौ चक्र

तत्त्रिज्याकृतिविश्लेषान्मूलं द्युज्याथ कोटिका ।
दोर्ज्यापक्रमकृत्योश्च भेदान्मूलमथापि वा ॥ २५ ॥

अन्त्यद्युज्याहता दोर्ज्या त्रिज्याभक्तेष्टकोटिका ।
त्रिज्याघ्नेष्टद्युजीवाप्ता चापितार्कभुजासवः ॥ २६ ॥

दोःप्राणलिप्तिकाभेदमविनष्टं तु पालयेत् ।
विषुवद्भाहता क्रान्तिः सूर्याप्ता क्षितिमौर्विका ॥ २७ ॥

त्रिज्याघ्नेष्टद्युजीवाप्ता चापिता स्युश्चरासवः ॥ २८a ॥

सेयमिष्टद्युवृत्तस्था क्षितिजोन्मण्डलान्तरम् ।
चरज्या सा स्ववृत्तांशप्रमिता यद्धनुश्चरम् । ८२२ ॥

घटिकावृत्तमार्गेण भ्राम्यति प्रवहोऽन्वहम् ।
भगोलं प्रेर्यते येन ग्रहनक्षत्रसंश्रयः ॥ ८२३ ॥

इष्टक्रान्त्यन्तरे तस्मात् स्वद्युवृत्ते द्युचारिणः ।
प्रवहप्रेरिता भ्राम्यन्त्युदग्दक्षिणतस्ततः ॥ ८२४ ॥

घटिकासमपार्श्वस्थं निरक्षक्षितिजं भवेत् ।
निरक्षदेशे यत्रार्कः सदोदेत्यस्तमेति च ॥ ८२५ ॥

स्वाक्षे स्वक्षितिजे ज्ञेयावुदयास्तमयौ रवेः ।
उन्मण्डलक्षितिजयोरन्तरालधनुश्चरम् ॥ ८२६ ॥

सौम्ये पूर्वमुदेत्यर्कः पश्चात्तेनास्तमेति च ।
अतश्चरेण द्विघ्नेन दिनं तत्र तु वर्धते ॥ ८२७ ॥

क्षीयते च निशा यस्मान्मिथो भिन्ने दिनक्षये ।
याम्ये पश्चादुदेत्यर्कस्तेन प्रागस्तमेति च ॥ ८२८ ॥

अतश्चरेण द्विघ्नेन तत्र तु क्षीयते दिनम् ।
वर्धते च निशा यस्माद् व्यस्तत्वं गोलयोर्मिथः ॥ ८२९ ॥

चरप्राणगतिः स्वर्णं याम्योदग्गोलयोस्ततः ।
उदयेऽस्तमये व्यस्तं ग्रहे रव्युदयावधौ ॥ ८३० ॥

मध्यार्कप्रमितं तुल्यरूपमेव सदा दिनम् ।
तुल्यत्वात् तद्गतेर्भिन्नं स्फुटार्कप्रमितं दिनम् ॥ ८३१ ॥

[रवेर्गतिकलाः]

लिप्ताप्राणान्तरं भानोर्दोःफलं च चरासवः ॥ २८b ॥

स्वर्णसाम्येन संयोज्या भिन्नेन तु वियोजयेत् ।
भानुमध्यमभुक्तिघ्नं चक्रलिप्ताहृतं फलम् ॥ २९ ॥

भानुमध्ये तु संस्कार्यं स्फुटभुक्त्याहृतं स्फुटे ॥ ३०a ॥

[ग्रहेषु चरस्य संस्कारप्रकारः]

उदक्स्थेऽर्के चरप्राणाः शोध्याः स्वं याम्यगोलगे ॥ ३०b ॥

व्यस्तमस्ते तु संस्कार्या, न मध्याह्नार्धरात्रयोः ।
युग्मौजपदयोः स्वर्णं रवौ प्राणकलान्तरम् ॥ ३१ ॥

दोःफलं पूर्ववत्कार्यं रवेरेभिर्द्युचारिणाम् ।
मध्यभुक्तिं स्फुटां वापि हत्वा चक्रकलाहृतम् ॥ ३२ ॥

स्वर्णं कार्यं यथोक्तं, तद् व्यस्तं वक्रगतौ स्फुटे ॥ ३३a ॥

भिन्नत्वाद् दोःफलप्राणकलान्तरचरैर्गतैः ।
तदृक्षचक्रलिप्तानां भ्रमकालाद् दिनं यतः ॥ ८३२ ॥

दोःफलाद्युपयुक्तार्कात् कर्तव्या दोःफलादयः ।
तत्कृतस्य विशेषस्य तेष्वर्केऽपि च सम्भवात् ॥ ८३३ ॥

अर्कतद्दोःफलादीनां यदिष्टा तुल्यकालता ।
अन्यथा भिन्नकालत्वाद् व्रजन्त्यस्फुटताममी ॥ ८३४ ॥

दिनभेदादर्कभेदो दोःफलादेर्भिदा ततः ।
इत्यन्योन्याश्रयो दोषस्त्वविशेषान्निरस्यते ॥ ८३५ ॥

इति ।

[चरसंस्कारेण दिनरात्रिमानम्]

अहोरात्रचतुर्भागे चरप्राणान् क्षिपेदुदक् ॥ ३३b ॥

याम्ये शोध्या दिनार्धं तद् रात्र्यर्धं व्यत्ययाद् भवेत् ।
दिनक्षपे द्विनिघ्ने ते चन्द्रादेः स्वैश्चरासुभिः ॥ ३४a ॥

अहोरात्रचतुर्भागे इति (33b-34)—

[चरसंस्कारवासना]

राशिकूटायनान्तौ द्वौ व्यस्तदिक्कौ समोदयौ ।
सौम्यायनान्ते क्षितिजं याते वा दक्षिणोत्तरम् ॥ ८३६ ॥

याम्यं भकूटं याम्ये च सौम्ये गच्छति तद्वयम् ।
परस्परानुसारित्वात् सदैव तु तयोर्द्वयोः ॥ ८३७ ॥

परमक्रान्तितुल्या च भकूटस्योन्नतिः परा ।
अयनान्तौ यदा साक्षौ दक्षिणोत्तरमण्डले ॥ ८३८ ॥

कोटयपक्रम[1]तुल्या स्यात्ततोऽन्यत्र तदुन्नतिः ।
अयनान्तोन्नतिवशाद् भकूटस्योन्नतिस्ततः ॥ ८३९ ॥

भकूटस्योन्नतिवशाद् भवेत् क्षेपाग्रमुन्नतम् ।
भकूटाभिमुखं सर्वे विक्षिप्यन्ते ग्रहा यतः ॥ ८४० ॥

कोट्यपक्रम[2]कोटिघ्नः क्षेपस्त्रिज्याहृतः स्फुटः ।
क्षेपस्यास्य तथा क्रान्तेः क्रान्तियोगान्तरात् स्फुटः ॥ ८४१ ॥

मिथः कोटिहतत्रिज्याहरणाभ्यां च तद्विधिः ।
ययोर्योगो वियोगो वा दोःक्रान्तिक्षेपशालिनाम् ॥ ८४२ ॥

अन्त्यक्रान्तीष्टविक्षेपौ मिथः कोटिज्यया हतौ ।
तद्योगविरहाद्यन्त्यक्रान्तिस्त्रिज्याहृता स्फुटा ॥ ८४३ ॥

तत् त्रिज्याकृतिविश्लेषान्मूलं द्युज्यान्तिमा भवेत् ।
अन्त्यद्युज्याहृता दोर्ज्या त्रिज्याभक्तेष्टकोटिका ॥ ८४४ ॥

व्याख्या—1, 2. C. कोटयापक्रम

[चन्द्रस्फुटः]

इन्दूच्चयोः स्वदेशोत्थचरज्यानीतचरादिजम् ।
संस्कारं मध्यमे कृत्वा स्फुटीकार्यो निशाकरः ॥ ३५ ॥

क्रान्तिज्या क्षेपकोटिघ्ना क्षेपोऽन्त्यक्रान्तिताडितः ।
व्यस्तं तद्योगविश्लेषात् कोटिज्या त्रिज्यया हृता ॥ ८४५ ॥

दोर्ज्याहृता परक्रान्तिकोटिस्त्रिज्याहृताऽथवा ।
भूयस्त्रिज्याहृता स्वद्युज्याप्ता सा कालदोर्गुणः ॥ ८४६ ॥

तच्चापं कालदोःप्राणाः पदयोः प्रथमान्त्ययोः ।
चरप्राणास्ततः शोध्याः पदयोस्त्वन्ययोः क्षिपेत् ॥ ८४७ ॥

काललग्नं तदेवाद्ये द्वितीये तु तदूनितम् ।
राशिषट्कं पदेऽन्यस्मिंस्तद्युतं चरमे पुनः ॥ ८४८ ॥

तदूनं मण्डलं लग्नकालः स्यात् स्वोदयो विधोः ।
क्षेपसंस्कृतया क्रान्त्या कर्तव्या स्वचरासवः ॥ ८४९ ॥

दिनान्तरितयोरेवं नीतयोः काललग्नयोः ।
विवरं दिनमानं स्याच्चक्रलिप्तासमन्वितम् ॥ ८५० ॥

एतत्सर्वमभिप्रेत्य चन्द्रादेः स्वैश्चरासुभिः ।
तद्दिनानयनं प्रोक्तमाचार्यैः सूक्ष्मदर्शिभिः ॥ ८५१ ॥

दिनपार्श्वस्थयोः काललग्नयोर्विवरं दिनम् ।
तात्कालिकार्कदोःप्राणचरभेदेन भिद्यते ॥ ८५२ ॥

इन्द्वोरविकृतक्षेपक्रान्तितत्कोटिभेदतः ।
दोःप्राणचरतो भिन्ने काललग्ने ततो दिनम् ॥ ८५३ ॥

इति ।

[चन्द्रस्फुटः]

इन्दूच्चयोरिति (35-39)—

[चराविज्यानां चापीकरणम्]

स्वोच्चात् स्ववृत्तपादेन विप्रकृष्टे स्वमध्यमे ।
नीचोच्चवृत्तव्यासार्धेनोच्चासन्नस्फुटग्रहः ॥ ८५४ ॥

दोःकोटिज्ये तु सप्तघ्ने अशीत्याप्ते फले उभे ।
चापितं दोःफलं कार्यं स्वमध्ये स्फुटसिद्धये ॥ ३६ ॥

[चरज्यादीनां चापीकरणम्]

ज्याचापान्तरमानीय शिष्टचापघनादिना ।
युक्त्वा, ज्यायां धनुः कार्यं पठितज्याभिरेव वा ॥ ३७ ॥

उच्चमध्यान्तरे स्वीयवृत्तव्यासार्धसम्मिते ।
मध्यस्फुटान्तरं स्वोच्चान्नीचव्यासार्धसम्मितम् ॥ ८५५ ॥

तन्मध्ये च तयोस्तादृङ्नियमेन विना कथम् ।
उच्चमध्यान्तरालज्यां मन्दवृत्तहृतां ततः ॥ ८५६ ॥

विभजेद् ग्रहवृत्तेन स्फुटमध्यान्तराप्तये ।
यद्वोच्चमध्यमेवज्यं[1] मन्दान्त्यफलताडितम् ॥ ८५७ ॥

त्रिज्यया विभजेल्लब्धं स्फुटमध्यान्तरं भवेत् ।
अपवर्तितयोस्तत्र वृत्तयोरर्धपञ्चमैः ॥ ८५८ ॥

तादृङ्नीचोच्चवृत्तघ्नां तादृग्वृत्तेन संहरेत् ।
मध्यस्फुटान्तरं लब्धं कर्णवृत्तस्य केन्द्रतः ॥ ८५९ ॥

तन्नेमिगतनीचोच्चवृत्तकेन्द्रानुसारतः ।
या कर्णवृत्तनेम्यन्ता रेखा सा तद्युतोनिता ॥ ८६० ॥

प्रतिवृत्तगतो मध्यः कर्णवृत्ते स्फुटो भवेत् ।
उक्तं चापघने षड्घ्नत्रिज्यावर्गे कलासमम् ॥ ८६१ ॥

वशांशे तत्कृतेश्चापज्यान्तरं विकलासमम् ।
एकादिघ्नात्ततस्त्रिज्यावर्गतो वशभिर्हृतात् ॥ ८६२ ॥

घनमूलं तु यल्लब्धं तत्तुल्ये धनुषि स्थिते ।
एकद्व्याद्या विलिप्ताः स्युश्चापज्याविवरोद्भवाः ॥ ८६३ ॥

तदूनं चापमर्धज्या तद्युता ज्या च तद्धनुः ।
कार्योऽविशेषश्चापाप्तौ चापाल्पत्वे वृढं च तत् ॥ ८६४ ॥

इति ।

व्याख्या—1. A. यदोच्चभेदमध्यज्यं

118,18,103

त्रिखरूपाष्टभूनागरुद्रैः त्रिज्याकृतिः समा ।
एकादिघ्न्या दशाप्ताया घनमूलं, ततोऽपि यत् ॥ ३८ ॥

तन्मितज्यासु योज्याः स्युरेकद्व्याद्या विलिप्तिकाः ।
चरदोःफलजीवादेरेवमल्प[1]धनुर्नयेत् ॥ ३९ ॥

[गोलसंस्थानम्]

"निजमन्दपरिधिगोच्चं केन्द्रीकृत्य भ्रमन्ति कक्ष्यासु ।
विहगा, रविचन्द्रमसोर्भगोलमध्यं स्वमन्दवृत्तिमध्यम् ॥ ८६५ ॥

अपमण्डलमध्यस्थस्वशीघ्रवृत्तिसङ्गतोच्चमन्येषाम् ।
पाताद् विक्षिप्तमुदङ् मृदुवृत्तार्धं, ततोऽन्यतोऽन्यार्धम् ॥ ८६६ ॥

चन्द्रादीनां मन्दानुसारतः स्वस्वकक्ष्याः स्युः ।
क्षयवृद्धिः सर्वेषां परिधेर्मान्दस्य तु स्वकर्णवशात् ॥ ८६७ ॥

प्रायो भ्रमतां स्वे स्वे कक्ष्यावलये तु योजनैस्तुल्या ।
लिप्ताभेदैर्भिन्ना गतिर्ग्रहाणां मिथो वापि ॥ ८६८ ॥
(गोलसारः, २. १०-१३)

[भगोले ग्रहभ्रमः]

गोलसारे स्फुटक्षेत्रसंस्थानमिति वर्णितम् ।
प्रतिमण्डलतो गच्छेत् स्वया गत्या ग्रहः सदा ॥ ८६९ ॥

तत्केन्द्रं मन्दनीचोच्चवृत्तनेम्यां भ्रमेत् पुनः ।
मन्दोच्चगत्या मन्दोच्चवृत्तनेम्युच्चगं ततः ॥ ८७० ॥

अर्केन्द्वोर्मन्दनीचोच्चवृत्तकेन्द्रं प्रतिष्ठितम् ।
भगोलमध्येऽन्येषां तु शीघ्रवृत्तस्य नेमिगम् ॥ ८७१ ॥

प्रतिवृत्तसमं वृत्तं कक्ष्याख्यं वा प्रकल्प्यताम् ।
तदास्य केन्द्रमीचोच्चवृत्तकेन्द्राश्रितं भवेत् ॥ ८७२ ॥

कक्ष्यावृत्तस्य नेम्यां च कल्प्यं नीचोच्चमण्डलम् ।
कक्ष्यानेमिस्थतत्केन्द्रं विदुस्तन्मध्यमग्रहम् ॥ ८७३ ॥

यतो मध्यमया गत्या कक्ष्यानेम्यां भ्रमेद् दिनम् ।
उच्चगत्या तु तन्नेम्या ग्रहो गच्छन् प्रकल्प्यते ॥ ८७४ ॥

मूलम्—1. A. मल्पं

स्ववृत्ते तद्गतः खेटो यावद् राश्यंशलिप्तकः ।
नीचोच्चकेन्द्रं कक्ष्यायां तावद् राश्यादिकं भवेत् ॥ ८७५ ॥

कक्ष्याकेन्द्रस्थनीचोच्चवृत्तनेम्यां भ्रमत् पुनः ।
प्रतिवृत्तस्य केन्द्रं तद् यावद् राश्यंशलिप्तिकम् ॥ ८७६ ॥

कक्ष्यानेमिस्थनीचोच्चनेम्यां तावति स ग्रहः ।
स्ववृत्तस्योच्चवृत्तेन स्वोच्चासन्नयुतौ स च ॥ ८७७ ॥

प्रतिमण्डलकेन्द्रस्य स्वोच्चभुक्त्या प्रतिक्षणम् ।
नीचोच्चवृत्तपरिधौ कल्प्येत यदि तु भ्रमः ॥ ८७८ ॥

यथा पूर्वापरैकैव रेखा याम्योत्तरापि च ।
तथा च तत्तत्परिधौ तद्भ्रमः परिकल्प्यताम् ॥ ८७९ ॥

कक्ष्यानेमिस्थनीचोच्चवृत्तस्यापि तथा भ्रमः ।
प्रतिमण्डलकेन्द्रं तद्वृत्ते भ्राम्यति यादृशि ॥ ८८० ॥

कृत्स्नं तत्परिधिः भ्राम्येत् प्रदेशेऽन्यत्र तादृशि ।
ग्रहवृत्तस्य नेमिस्थो ग्रहो भ्राम्यति तद्वशात् ॥ ८८१ ॥

स्वाश्रयभ्रमणाधीनभ्रमोऽसौ स्वभ्रमं विना ।
कक्ष्याकेन्द्रस्थनीचोच्चवृत्तनेमिस्थितस्य यः ॥ ८८२ ॥

भ्रमः स कक्ष्यानेमिस्थे नीचोच्चे वा प्रकल्प्यताम् ।
सा त्विहोच्चवशाद् भुक्तिः स्वव्यापारेण कल्पिता ॥ ८८३ ॥

ग्रहे वृत्ते ग्रहस्यापि स्वव्यापारेण या गतिः ।
नीचोच्चवृत्तकेन्द्रस्य कक्ष्यानेम्यां गतिश्च सा ॥ ८८४ ॥

कक्ष्यानेम्यां हि नीचोच्चकेन्द्रभुक्तिस्तु मध्यमा ।
केन्द्रनेम्योर्द्वयोस्तुल्यं वृत्तमार्गेण गच्छतोः ॥ ८८५ ॥

सिध्येत् केन्द्रभ्रमादेव तन्नेमिस्थग्रहभ्रमः ।
नीचोच्चवृत्तनेमिस्थं प्रतिमण्डलमेव वा ॥ ८८६ ॥

कक्ष्यानेमिस्थनीचोच्चवृत्तकेन्द्रमथापि वा ।
ग्रहगत्याश्रयत्वेन कल्प्यते गोलवित्तमैः ॥ ८८७ ॥

[मन्दशीघ्रकर्णौ]

आद्ये पदे चतुर्थे च व्यासार्धे कोटिजं फलम् ।
युक्त्वा त्यक्त्वान्ययोस्तद्दोःफलवर्गैक्यजं पदम् ॥ ४० ॥

तत्कक्ष्यावृत्तनेमिस्थनीचोच्चग्रहवृत्तयोः ।
उच्चासन्ने तु सम्पाते नेम्योस्तिष्ठेत् स्फुटग्रहः ॥ ८८८ ॥

कक्ष्यानीचोच्चयोर्वापि स्वान्यवृत्तद्वयं विना ।
कक्ष्यावृत्तं च तन्नेमिस्थोच्चनीचं च यद् द्वयम् ॥ ८८९ ॥

नीचोच्चं निजनेमिस्थग्रहवृत्तं च यद्द्वयम् ।
ताभ्यां द्वयाभ्यां साध्या स्यात् स्फुटभुक्तिर्द्युचारिणाम् ॥ ८९० ॥

चतुर्भिरथवा वृत्तैर्युगपत्परिकल्पितैः ।
कक्ष्यामण्डलनेमिस्थनीचोच्चग्रहवृत्तयोः ॥ ८९१ ॥

उच्चासन्ने तु सम्पाते दृश्यते द्युचरस्ततः ।
यत्कक्ष्याग्रहनीचोच्चवृत्तकेन्द्रसमुद्गतम् ॥ ८९२ ॥

सूत्रं तदग्रे द्युचरो भवेत् स्वोच्चयुतस्ततः ।
नीचोच्चवृत्ते कक्ष्यायां वृत्तपादान्तरस्थिते ॥ ८९३ ॥

तन्नेमिस्थाद् ग्रहादुच्चभागः पादान्तरस्थितः ।
ततोऽपि पादान्तरितो ग्रहो नीचांशसंश्रितः ॥ ८९४ ॥

एवमेवेतरार्धेऽपि तयोरन्तरयोस्ततः ।
एकेनैवान्तरालेन तदन्यदनुपाततः ॥ ८९५ ॥

इति ।

[आद्ये पदे चतुर्थे चेति][1] (40-42)—

[मन्द-शीघ्रकर्णौ]

ग्रहोच्चसूत्रान्तरालं ग्रहवृत्तगतं[2] भुजा ।
कोटिस्तत्केन्द्रतो दोर्ज्यामूलान्ता परिकल्प्यते ॥ ८९६ ॥

व्याख्या—1. A. B. C. give the *pratika* as आद्यन्तपदग इति । C. adds मूलश्लो०

2. B. गता

कर्णः स्यादविशेषोऽस्य कार्यो मन्दे[1], चले न तु ।

[मन्दकर्णः]

दोःकोटिफलनिघ्नाद्यत्[2] कर्णात् त्रिज्याहृते फले ॥ ४१ ॥

ताभ्यां कर्णः पुनः साध्यो भूयः पूर्वफलाहतात् ।
तत्तत्कर्णात् त्रिभज्याप्तफलाभ्यामविशेषयेत् ॥ ४२ ॥

केन्द्रान्तरं चान्त्यफलं स्यात् कक्ष्याग्रहवृत्तयोः ।
दोर्ज्यामूले तु कक्ष्यातो बहिरन्तर्गते क्रमात् ॥ ८९७ ॥

कोटयन्त्यफलयोर्योगभेदाभ्यां स्फुटकोटिका ।
तयोर्वर्गयुतेर्मूलं कक्ष्याकेन्द्रग्रहान्तरम् ॥ ८९८ ॥

कर्णः स एव विज्ञेयः प्रतिवृत्तकलामितः ।
तज् ज्ञेयवृत्तव्यासार्धज्ञातवृत्तकलामितम् ॥ ८९९ ॥

कक्ष्यावृत्तस्य तन्नेमिस्थोच्चनीचस्य च द्वयोः ।
केन्द्रद्वयावभेदी यो मार्गस्तस्माद् ग्रहान्तरम् ॥ ९०० ॥

दोःफलं यत्तु तन्मूलान्तरं नीचोच्चकेन्द्रतः ।
कोटीफलं तद्युतोना त्रिज्या कक्ष्याख्यवृत्ततः ॥ ९०१ ॥

क्रमाद् दोःफलमूले तु बहिरन्तर्गते सति ।
सा तु दोःफलमूलस्य कक्ष्याकेन्द्रस्य चान्तरम् ॥ ९०२ ॥

तत्कृतौ दोःफलकृतिं युक्त्वा[1] कर्णः पदीकृतः ।
एवं कर्णो द्विधा साध्यः स तु मान्दो विशिष्यते ॥ ९०३ ॥

मान्दं नीचोच्चवृत्तं तत्कर्णवृत्तकलामितम् ।
यतस्तत्कर्णवृद्धिक्षयानुसारीदमुच्यते ॥ ९०४ ॥

मन्दकर्णे स्वलिप्ताभिः प्रमिते त्रिज्यया समे ।
पठितः परिधिर्मान्दः कर्णवृत्तकलामितः ॥ ९०५ ॥

मूलम्—1. B. मान्दे 2. A. B. निघ्नाद् यत्

व्याख्या—1. B. त्यक्त्वा for युक्त्वा

[मन्दकर्णे प्रकारान्तरम्]

विस्तृतिदलदोःफलकृति-
वियुतिपदं कोटिफलविहीनयुतम् ।
केन्द्रे मृगकर्किंगते
स खलु विपर्ययकृतो भवेत् कर्णः ॥ ४३ ॥

ऊनाधिके ततः कर्णे प्रतिवृत्तकलामिते ।
तेन कर्णेन दोःकोटिफले ताभ्यां च तन्नयेत् ॥ १०६ ॥

अन्योन्याश्रयता चैवामविशेषान्निरस्यते ।
तत्तत्कर्णाद्दोःकोटिघाताभ्यां त्रिज्यया हृते ॥ १०७ ॥

ताभ्यां त्रिभज्यया चापि प्राग्वत् कर्णं मुहुर्नयेत् ।
अथवा कोटिदोर्ज्यावाविशिष्टान्त्यफलैर्नयेत् ॥
अविशेषं विना यद्वा मन्दकर्णं नयेत् तथा ॥ १०८ ॥

विस्तृतीति (43-45)—

[अविशेषं विना मन्दकर्णः]

मध्यस्फुटान्तरं मन्दे कर्णवृत्तकलामितम् ।
मध्यस्फुटान्तरकृतिं त्यजेत् त्रिज्याकृतेस्तवा[1] ॥ १०९ ॥

तन्मूलं विवरं कक्ष्याकेन्द्रदोःफलमूलयोः ।
भेदो दोःफलमूलस्य यस्तु नीचोच्चकेन्द्रतः ॥ ११० ॥

कोटिजं तत् त्यजेत् कक्ष्याकेन्द्रदोःफलमूलयोः ।
भेदाद् दोःफलमूलेऽस्मिन् कक्ष्यावृत्ताद् बहिर्गते ॥ १११ ॥

अन्तर्गते तत् प्रक्षेप्यं कक्ष्याव्यासदलं यतः ।
कक्ष्याव्यासदलं तत् कर्णवृत्तकलामितम् ॥ ११२ ॥

व्याख्या—1. B. कृतेः सदा 2. A. om. यतः

3. C. om. स्वकलामिता

तेन हृता त्रिज्याकृति-
रयत्नविहितोऽविशेषकर्णः स्यात् ।
इति वा कर्णः साध्यो
मान्दे सकृदेव माधवप्रोक्तः ॥ ४४ ॥

[मन्दकर्णेन रविस्फुटः]

त्रिज्याघ्नो दोर्गुणः कर्णभक्तः[1] स्फुटभुजागुणः ।
तद्धनुः संस्कृतं स्वोच्चं नीच्चं वा युक्तितः स्फुटम् ॥ ४५ ॥

[मन्दस्फुटः]

कोटीफलयुतोनायास्त्रिज्याया दोःफलस्य च ।
वर्गयोगपदं कर्ण इति पूर्वं प्रदर्शितम् ॥ ९१३ ॥
कक्ष्यावृत्तव्यासदलेनेत्थं कर्णमितेन च ।
प्रतिवृत्तमिदं कर्णवृत्तव्यासार्धमानयेत् ॥ ९१४ ॥
तत्पुनर्व्यस्तकर्णेन त्रिज्यावर्गात्तु लभ्यते ।
ग्रहोच्चसूत्रविवरं ग्रहवृत्तकलामितम् ॥ ९१५ ॥
कर्णवृत्तमितं कृत्वा चापितं तत्कलामितम् ।
सम्पातात् कर्णवृत्तोच्चसूत्रयोः स्याद् ग्रहावधि ॥ ९१६ ॥
कर्णवृत्तोच्चसम्पाते धनर्णं तद् यथाविधि ।
एवं कृत्वा कर्णवृत्ते ग्रहस्य गतिरिष्यते ॥ ९१७ ॥
सम्पाते ग्रहवृत्तोच्चसूत्रयोर्यावती कला ।
तावती कर्णवृत्तेऽपि सूत्रे केन्द्रद्वयस्थितेः ॥ ९१८ ॥

यतः[1]—

ततो ग्रहोच्चसूत्रान्तरालं कर्णकलामितम् ।
तद्धनुर्योगभेदाभ्यां स्वोच्चे सिद्ध्येत् स्फुटग्रहः ।
व्यस्तकर्णस्फुटोच्चान्तरालदोर्गुणतोऽथवा ॥ ९१९ ॥

मूलम्—1. C. कर्ण; भक्तः
व्याख्या—1. A. om. यतः

[रविस्फुटाद् ग्रहमध्यमः]

अर्कस्फुटेनानयनं प्रकुर्यात्
स्वमध्यमस्यात्र वितुङ्गभानोः ।
भुजागुणं कोटिगुणं च कृत्वा
मृगादिकेन्द्रेऽन्त्यफलाख्यकोट्योः[1] ॥ ४६ ॥

भेदः, कुलीरादिगते तु योग-
स्तद्वर्गयुक्ताद् भुजवर्गतो यत् ।
पदं विपर्यासकृतः स कर्णः,
त्रिज्याकृतेस्तद्विहृतस्तु[2] कर्णः ॥ ४७ ॥

अर्कस्फुटेनेति (46-50)—

[रविस्फुटाद् ग्रहमध्यमः]

कर्णवृत्ते स्फुटोच्चान्तरालज्या स्वकलामिता[1] ।
तदुच्चसूत्रसम्पातात् कोटिस्तत्केन्द्रगामिनी ॥ ९२० ॥

तदन्त्यफलयोर्योगो विश्लेषो वा यथोचितम् ।
प्रतिमण्डलकेन्द्रस्य दोर्ज्यामूलस्य चान्तरम् ॥ ९२१ ॥

तद्दोर्वर्गयुतेर्मूलं प्रतिमण्डलकेन्द्रतः ।
ग्रहावधि व्यासदलं कर्णवृत्तकलामितम् ॥ ९२२ ॥

व्यासार्धं प्रतिवृत्तस्य त्रिज्यैव स्वकलामिता ।
तदेव व्यस्तकर्णः स्यात् कर्णवृत्तकलामितम् ॥ ९२३ ॥

त्रिज्यातुल्ये व्यस्तकर्णे कर्णो न्यूनाधिकस्ततः ।
ततस्त्रैराशिकेनात्र मन्दकर्णस्फुटो भवेत् ॥ ९२४ ॥

उच्चोनस्फुटतो दोर्ज्यां मन्दकर्णहतां हरेत् ।
त्रिज्यया तद्गुणां दोर्ज्यां व्यस्तकर्णेन वा हरेत् ॥ ९२५ ॥

मूलम्—1. A. B. $C_{3\cdot 9}$ कोटघा   2. C_6. विहृतः स कर्णः
व्याख्या—1. C. om. स्वकलामिता

तेनाहतामुच्चविहीनभानो-
जींवां भजेत् व्यासदलेन, लब्धम् ।
स्वोच्चे क्षिपेच्चापितमाद्यपादे,
चक्रार्धतः शुद्धमपि द्वितीये ॥ ४८ ॥

चक्रार्धयुक्तं तु तृतीयपादे,
संशोधितं मण्डलतश्चतुर्थे ।
एवंकृतं सूक्ष्मतरं हि मध्यं
पूर्वं पदं यावदिहाधिकं स्यात् ॥ ४९ ॥

अन्त्यात् फलात्[1] कोटिगुणं[2] चतुर्थं
त्वारभ्यते[3] यद्यधिकात्र कोटिः ।
सर्वत्र विष्कम्भदलं श्रुतौ वा
व्यासार्धके स्याद् विपरीतकर्णः ॥ ५० ॥

लब्धचापं धनर्णं स्यात् स्वोच्चे मध्यमसिद्धये ।
यादृशो नियमस्तत्र[1] व्यस्तकर्णत्रिजीवयोः ॥ ९२६ ॥

तादृशो नियमो वेद्यस्त्रिजीवामन्दकर्णयोः ।
कर्णस्त्रैराशिकेनातो व्यस्तकर्णाद् विधीयते ॥ ९२७ ॥

मध्यमात् स्फुटसंसिद्धिर्दोःफलाद् यदि केवलात् ।
मध्यसिद्धिस्फुटात् तस्मात् कर्णघ्नात् त्रिज्यया हृतात् ॥ ९२८ ॥

अथ स्फुटोच्चान्तरदोर्गुणं श्रुतिहतं हरेत् ।
त्रिज्यया लब्धचापेन कृते स्वोच्चे स्वमध्यमः ॥ ९२९ ॥

तदेव चापितं स्वोच्चे चक्रार्धं तेन वर्जितम् ।
चक्रार्धयुक्तं चक्राच्च त्यक्तं पदवशात् क्षिपेत् ॥ ९३० ॥

मूलम्—1. $C_{1\cdot2\cdot6\cdot8}$ पदात् 2. $B.C._{3\cdot4\cdot8}$ गुणः
3. $C_{3\cdot8}$ चारभ्यते

व्याख्या—1. A. यदृशा नियमास्तत्र

[स्फुटान्मध्यमे प्रकारान्तरम्]

अर्केन्द्वोः[1] स्फुटतो मृदूच्चरहिताद् दोःकोटिजाते फले
नीत्वा, कर्किमृगादितो विनिमयेनानीय कर्णं सकृत् ।
त्रिज्यादोःफलघाततः श्रुतिहृतं चापीकृतं, तत् स्फुटे
केन्द्रे मेषतुलादिगे धनमृणं तन्मध्यसंसिद्धये ॥ ५१ ॥

आद्ये पदे कोटिजीवा यदान्त्यफलसम्मिता ।
तावदाद्यं पदं कल्प्यं ततः पश्चाद् द्वितीयकम् ॥ ९३१ ॥

चतुर्थेऽपि पदे यावत् कोट्यन्त्यफलतुल्यता ।
तावत् कल्प्यं तृतीयं तु पदं पश्चाच्चतुर्थकम् ॥ ९३२ ॥

इति ।

अर्केन्द्वोः स्फुटत इति (51)—

[प्रकारान्तरेण मध्यमः]

तत्रोच्चरेखाग्रहयोर्भेदः कर्णकलामितः ।
तं कर्णवृत्तकेन्द्रस्थे नीचोच्चे परिकल्पयेत् ॥ ९३३ ॥

परान्तरालमाद्यं तत्रान्यविष्टान्तरं भवेत् ।
ग्रहोच्चसूत्रविवरं दोःफलं तद् भवेदिह ॥ ९३४ ॥

प्रतिमण्डलकेन्द्राग्रं नीचोच्चे तं प्रकल्पयेत् ।
तस्य दोःफलमूलस्य[1] ग्रहसूत्रेण संयुतेः[2] ॥ ९३५ ॥

कर्णमण्डलकेन्द्रान्तं तस्य कोटिफलं भवेत् ।
कोटीफलोनं व्यासार्धं तत्र दोःफलमूलतः ॥ ९३६ ॥

ग्रहान्तरालं तद्बाहुफलवर्गैक्यमूलतः ।
ग्रहान्तरालं तद्वृत्तकेन्द्रात् कर्णकलामितम् ॥ ९३७ ॥

उच्चासन्ने ग्रहे चैवं नीचासन्ने विधिः पुनः ।
कृत्स्नव्यासो ग्रहस्पृष्टः कर्णवृत्तकलामितः ॥ ९३८ ॥

मूलम्—1. B. अर्केन्दोः; C. अर्केन्दु

व्याख्या—1. A. फलसूत्रस्य　　2. A. संयुते

[मन्दकर्णे प्रकारान्तरम्]

मध्यतः स्फुटतश्चोच्चमुज्झित्वा तद्भुजे उभे ।
गृहीत्वाद्यां तयोस्त्रिज्याहताऽन्याप्ता, श्रुतिः स्फुटा[1] ॥ ५२ ॥

तद्व्यासार्धं कोटिफलयुक्तं कोटिरिहेष्यते ।
प्रतिमण्डलकेन्द्रान्तं कोटिमूलात्तु दोःफलम् ॥ ९३९ ॥
सा भुजाथ तयोर्वर्गयोगमूलं तु तच्छ्रुतिः ।
तदेव ग्रहवृत्तस्य व्यासार्धमिति कथ्यते ॥ ९४० ॥
यत्कक्ष्यावृत्तनेमिस्थितनीचोच्चवृत्तयोः ।
सूत्रं केन्द्रद्वयोद्भेदि कर्णवृत्तस्य नेमिगम् ॥ ९४१ ॥
ततो ग्रहान्तरं यत्तद्दोःफलं तत्कलामितम् ।
सूत्रं केन्द्रद्वयं स्पृष्टं तद्युक्तोनं स्फुटग्रहः ॥ ९४२ ॥
तस्य सूत्रस्य सम्पाते कक्ष्यायां यावती कला ।
तत्कर्णवृत्तनेम्योश्च सम्पाते तावती कला ॥ ९४३ ॥
केन्द्रैक्यात् कर्णकक्ष्यामण्डलयोरुभयोरपि ।
तस्य मध्यमतुल्यत्वान्मध्ये दोःफलसंस्कृतेः ॥ ९४४ ॥
ज्ञेयभोगग्रहे कर्णवृत्ते सिध्येत् स्फुटग्रहः ।
व्यत्ययेनास्य संस्कारात्[2] स्फुटे स्यान्मध्यमः स तु ॥ ९४५ ॥
मध्यमात् स्फुटसंसिद्धिर्दोःफलाद् यदि केवलात् ।
मध्यसिद्धिः स्फुटात्तस्मात् कर्णघ्नात् त्रिज्यया हृतात् ॥
त्रिज्याघ्नाद् व्यस्तकर्णाप्तादथवा फलसाम्यतः ॥ ९४६ ॥

इति ॥

मध्यत इति (52)—

[प्रकारान्तरेण मन्दकर्णः]

यादृशो नियमस्तत्र मन्दकर्णत्रिजीवयोः ।
स्वोच्चोनमध्यस्फुटयोर्दोर्ज्ययोरपि तादृशः ॥ ९४७ ॥

मूलम्—1. A. स्फुटः
व्याख्या—1. A. व्यत्ययेनान्यसंस्कारात्

[रविचन्द्रयोः तत्कालस्फुटः]

चन्द्रबाहुफलवर्गशोधितत्रिज्यकाकृतिपदेन संहरेत् ।
तस्य कोटिफललिप्तिकाहतां केन्द्रभुक्तिमिह, यच्च लभ्यते ॥ ५३ ॥

स्वोच्चोनमध्यदोर्ज्यायास्त्रिज्याघ्नायास्ततो हृतः ।
मन्दकर्णो भवेत् सूक्ष्मः स्वोच्चोनस्फुटदोर्ज्यया ॥ ९४८ ॥

इति ।

चन्द्रबाहुफलेति (53-54)—

[रवीन्द्वोः स्फुटगतिवासना]

इष्टकाले ग्रहे स्वोच्चात् पदे यावति वर्तते ।
उच्चनीचावधिस्तत्र दोर्ज्यापदवशात् ग्रहात्[1] ॥ ९४९ ॥

ततोऽपरा च कोटिज्या दोर्ज्यातो व्यस्तविग्गता ।
यादृग् वेगोऽत्र दोर्ज्यायास्तादृक् तद्दोःफलस्य च ॥ ९५० ॥

तत्संस्कृते मध्यभोगे स्फुटभोग उदाहृतः ।
दोर्ज्यावृद्धिरिहाल्पा चेद् दोःफलस्यापि सा तथा ॥९५१॥

इतरेतरवृद्धिक्षयानुसारितया द्वयोः ।
सा च कोटिगुणे पूर्णे पूर्णा तत्राल्पकेऽल्पिका ॥९५२॥

ततः कोटिगुणेनैव तद्वृद्धिः परिकल्प्यते ।
ओजयुग्मपदाद्यन्त[2]दोर्ज्यावेगो धनुर्मितः ॥ ९५३ ॥

पूर्णत्वात् कोटिजीवाया दोर्ज्याह्रासप्रवृत्तितः ।
कोटिह्रासानुरूप्येण ततः सः क्षीयते क्रमात् ॥ ९५४ ॥

दोर्ज्यागतिश्चापगतेरल्पिका स्यात्ततः क्रमात् ।
दोर्ज्यावृद्धौ च सा कोट्यां क्षीणायां शून्यतामियात् ॥ ९५५ ॥

पदान्ते केन्द्रतः क्षीणा तद्वृद्धिर्वर्धते ततः ।
खण्डज्याक्रम्मिता दोर्ज्यागतिस्तत्र प्रकल्प्यते ॥ ९५६ ॥

व्याख्या—1. A. दोर्ज्याग्रहवशात् पदात् 2. B. पदान्यन्त

तद्विशोधय मृगादिके[1] गतेः,[2] क्षिप्यतामिह तु कर्कटादिके[3] ।
तद् भवेत् स्फुटतरा गतिर्विधोरस्य तत्समयजा, रवेरपि[4] ॥ ५४ ॥

खण्डानां च स्वकोटिज्यावृद्धिह्रासानुसारिता ।
कोटिज्यानिहतां तस्माद् दिनकेन्द्रगतिं हरेत् ॥ ९५७ ॥

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त्रिज्यया स्फुटवृत्तघ्नामशीत्या च विभाजिताम् ।
भूयस्त्रिज्याहृतां बाहुफलकोट्या च संहरेत् ॥ ९५८ ॥

लब्धं मध्यगतौ स्वर्णं केन्द्रे कर्किमृगादिगे ।
क्षणकेन्द्रगतिस्तत्र दिनक्षणगुणा सती ॥ ९५९ ॥

दिनकेन्द्रगतेस्तुल्या तत्कृत्स्नज्यापि तत्समा ।
दिनकेन्द्रगतेः कृत्स्नज्या पुनः स्यात् ततोऽल्पिका ॥ ९६० ॥

इष्टक्षणगतेर्भिन्ना प्रायस्तत्पार्श्वयोर्गतिः ।
दिनभुक्तेर्न षष्ट्यंशः स्वेष्टनाडीगतिस्ततः ॥ ९६१ ॥

तद्दिनार्धगतिः स्वोच्चाद् दिनगत्यर्धतोऽधिका ।
क्रमेण वर्धमानत्वात् गतेस्तत्पार्श्वयोर्द्वयोः ॥ ९६२ ॥

नीचस्थे तु ततोऽल्पैव क्षीणत्वात् पार्श्वयोर्द्वयोः ।
क्षीणत्वं तु यदा कोट्यास्तदा तुल्यं गतिद्वयम् ॥ ९६३ ॥

दिनमध्यगतिः कल्प्या दिनभुक्तिनया सदा ।
द्रष्टव्यं तदिदं चन्द्रस्फुटवाक्येषु सर्वदा ॥ ९६४ ॥

यत्र चन्द्रोच्चयोर्योगो दिनान्तान्नातिदूरगः ।
तद्दिने स्फुटभुक्तिर्या सैवास्तमयिकी गतिः ।
अस्तवाक्यान्तरं चेन्दोः स्फुटा ह्यौदयिकी गतिः ॥ ९६५ ॥

इति ।

मूलम्—1. C_6 मृगादिगे 2. C_6 गतौ
3. A. C_{6-9} कर्कटादिगे 4. C_{10} विधोरपि

[तत्कालनक्षत्रम्]

लिप्तीकृतो निशानाथः शतैर्भाज्योऽष्टभिः, फलम् ।
अश्विन्यादीनि भानि स्युः, षष्ट्या हत्वा गतागते ॥ ५५ ॥

गतगन्तव्यनाड्यः स्युः स्फुटभुक्त्योदयावधेः ।

] तत्कालतिथिः]

अर्कहीनो निशानाथो लिप्तीकृत्य विभज्यते ॥ ५६ ॥

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शून्याश्विपर्वतैर्लब्धास्तिथयो या गताः क्रमात् ।

[तत्कालकरणम्]

भुक्त्यन्तरेण नाड्यः स्युः षष्ट्या हत्वा गतागते ॥ ५७ ॥

तिथ्यर्धहारलब्धानि करणानि बवादितः ।
विरूपाणि सिते पक्षे सरूपाण्यसिते विदुः ॥ ५८ ॥

[तत्कालविष्कम्भः]

विष्कम्भाद्या रवीन्द्वैक्याद्योगाश्चाष्टशतीहृताः ।
भुक्तियुक्त्या गतैष्याभ्यां षष्टिघ्नाभ्यां च नाडिकाः ॥ ५९ ॥

[नक्षत्र-तिथि-योग-करणवासना]

लिप्तीकृत इत्यादि (55-59)—

नक्षत्रतिथियोगानां संवित्तिः करणस्य च ।
स्फुटग्रहाद् रवीन्द्वैक्यात् तद्भेदाच्च तदर्धतः ॥ ९६६ ॥

भचक्रस्वविभागांशैर्लभ्यन्ते हरणात् क्रमात् ।
अश्विन्यादीनि भानि स्युस्तिथयः प्रतिपन्मुखाः ।
विष्कम्भाद्यं च योगर्क्षं करणानि बवादितः ॥ ९६७ ॥

इति ।

[कुजादिस्फुटः]

मान्दं शैघ्रं पुनर्मान्दं शैघ्रं चत्वार्यनुक्रमात् ।
कुजगुर्वर्कजानां हि कर्माण्युक्तानि सूरिभिः ॥ ६० ॥

[स्फुटकर्म]

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दोःकोटिज्याष्टमांशौ स्वखाब्ध्यंशोनौ शनेः फले ।
दोर्ज्या त्रिज्याप्तसप्तैक्यं गुणो मान्दे कुजेड्ययोः ॥ ६१ ॥

39 82
नवाग्नयो द्व्यशीतिश्च हारौ दोःकोटिजीवयोः ।
पृथक्स्थे मध्यमे कार्यं दोःफलस्य धनुर्दलम् ॥ ६२ ॥
रविमध्यं विशोध्यास्मात् पृथक्स्थाद् बाहुकोटिके ।
आनीय बाहुजीवायास्त्रिज्याप्तं गुरुमन्दयोः ॥ ६३ ॥
षोडशभ्यो नवभ्यश्च, कुजस्यापि स्वदोर्गुणात् ।
53
त्रिज्याप्तं द्विगुणं शोध्यं त्रीषुभ्यः शिष्यते गुणः ॥ ६४ ॥

[ग्रहस्फुटवासना]

मान्दमित्यादि (60-68b)—

कर्णवृत्तं तदर्केन्द्वोर्भगोलाभिन्नकेन्द्रकम् ।
अतः सैव तयोर्भुक्तिः स्याद् भगोलकलामिता ॥ ९६८ ॥

भगोलमध्ये चान्येषां[1] शीघ्रनीचोच्चकेन्द्रकम् ।
तन्नेम्या मन्दनीचोच्चकेन्द्रं भ्राम्यत्यनुक्षणम्[2] ॥ ९६९ ॥

मन्दनीचोच्चनेम्यां च सर्वेषां प्रतिमण्डलम् ।
मन्दनीचोच्चकेन्द्रं स्वकर्णवृत्तस्य केन्द्रगम् ॥ ९७० ॥

शीघ्रनीचोच्चनेमिस्थकेन्द्रत्वादुभयोस्तयोः ।
प्रतिवृत्ततया कल्प्यं शैघ्रे तत्कर्णमण्डलम् ॥ ९७१ ॥

तत्रत्यग्रहभोगस्य ज्ञातत्वान्मन्दकर्मणा ।
यः शीघ्रकर्णः शीघ्रोच्चनीचकेन्द्राद् ग्रहावधिः ॥ ९७२ ॥

व्याख्या—1. A. वान्येषां 2. B. Gap for क्षणम्

अशीतिरेव तेषां हि हारस्ताभ्यां फले उभे ।
आनीय, पूर्ववत् कर्णं सकृत् कृत्वा,थ[1] दोःफलम् ॥ ६५ ॥

त्रिज्याघ्नं कर्णभक्तं यत् तद् धनुर्दलमेव च ।
मध्यमे कृतामान्दे तु संस्कृत्यातो विशोधयेत् ॥ ६६ ॥

मन्दोच्चं तत्फलं कृत्स्नं कुर्यात् केवलमध्यमे ।
तस्मात् पृथक्कृता[2]च्छैघ्रं प्राग्वदानीय चापितम् ॥ ६७ ॥

कृतमान्दे तु कर्तव्यं[3] सकलं, स्यात् स्फुटः स च ॥ ६८a ॥

[बुधशुक्रयोः स्फुटः]

बुधमध्यात् स्वमन्दोच्चं त्यक्त्वा दोःकोटिजीवयोः ॥ ६८b ॥

तद्व्यासार्धकृतं वृत्तं ज्ञेयभोगं तु मण्डलम् ।
दोःकोटिफलकर्णाद्यैर्गतिस्तत्रापि पूर्ववत् ॥ १७३ ॥

"ज्ञातभोगग्रहं वृत्तं सर्वत्र प्रतिमण्डलम् ।
कक्ष्यावृत्तं च तत्तुल्यं ज्ञेयभोगप्रवेशगम्" ॥ १७४ ॥
(सिद्धान्तदर्पणम् , 22)

ज्ञातज्ञेयग्रहगतिवृत्तकेन्द्रान्तरं तु यत् ।
तद्व्यासार्धकृतं वृत्तं कक्ष्याकेन्द्रे प्रकल्पयेत् ॥ १७५ ॥

नेम्यां चास्यां मन्दफलसंस्कृतग्रहकेन्द्रकम् ।
तेषु त्रिभिर्ज्ञेयभोगः पञ्चभिर्वा प्रकल्प्यताम् ॥ १७६ ॥

इति ।

[बुधशुक्रयोः स्फुटकर्मणि वैशिष्टयम्]

बुधमध्यादिति (68b-80)—

ज्ञातभोगग्रहं वृत्तं स्वल्पमन्यं महद् यदा ।
वृत्तस्य महतः केन्द्रं कबलीकुरुते न तु ॥ १७७ ॥

मूलम्— 1. C_1 कृत्वा तु   2. C_{10} पृथक्स्थितात्
3. C_1 संस्कार्यं for कर्तव्यं

षडंशाभ्यां फलाभ्यां तु कर्णः कार्योऽविशेषितः[1] ।
दोःफलं केवलं स्वर्णं केन्द्रे जूकक्रियादिगे ॥ ६९ ॥

एवंकृतं हि[2] यन्मध्यं स्फुटमध्यं बुधस्य तु ।
रविमध्यं ततः शोध्यं, दोःकोटिज्ये ततो नयेत् ॥ ७० ॥

दोर्ज्या द्विघ्ना त्रिभज्याप्ता शोध्यैकत्रिंशतो[3] गुणः ।
मन्दकर्णहतः सोऽपि त्रिज्याप्तः स्यात् स्फुटो गुणः ॥ ७१ ॥

वृत्तमल्पं तदा केन्द्रान्तरव्यासदलं तयोः ।
कक्ष्यावृत्तं प्रकल्प्यं स्यात् तन्नेमिस्थं तथापरम् ॥ ९७८ ॥

व्यासार्धं ज्ञेयवृत्तस्य कक्ष्याकेन्द्राद् ग्रहावधि ।
कक्ष्यानेमिस्थनीचोच्चवृत्ते तत्र ग्रहाश्रये ॥ ९७९ ॥

तत्केन्द्रस्य गतिः कल्प्या ग्रहसम्बन्धिनी गतिः ।
तन्नेमिस्थग्रहगतिरुच्चस्यापि प्रकल्प्यते ॥ ९८० ॥

यन्मन्दकर्णव्यासार्धं मण्डलं बुधशुक्रयोः ।
भगोलकेन्द्रं तन्नैव कबलीकुरुते ततः ॥ ९८१ ॥

शैघ्रं नीचोच्चवृत्तं स्वं[1] कक्ष्यावत् परिकल्प्यते ।
मन्दकर्णकृतं वृत्तं तन्नेम्यामुच्चनीचवत् ॥ ९८२ ॥

अत एव हि शीघ्रोच्चनीचवृत्तकलामितम् ।
उच्चनीचतया प्रोक्तं ग्रहवृत्तं बुधाच्छयोः ॥ ९८३ ॥

कुजादेः शीघ्रवृत्तं तु ग्रहवृत्तकलामितम् ।
अतो ग्रहगतिर्ज्ञेयभोगवृत्ते तु पूर्ववत् ॥ ९८४ ॥

कक्ष्यावृत्तस्य परिधौ रविभुक्तकलामिते ।
मृदुकर्णवृत्तकेन्द्राक्रान्ते शैघ्रं तु दोःफलम् ॥ ९८५ ॥

मूलम्— 1. $C_{1-5\cdot10}$ कार्योऽविशेषतः 2. A. $C_{6\cdot7}$ तु for हि
3. C_1 त्रिंशको

व्याख्या—1. A. वृत्तस्य

तद्धते बाहुकोटिज्ये खाहिभक्ते फले उभे ।
ताभ्यां कर्णं सकृन्नीत्वा त्रिज्याघ्नं दोःफलं हरेत् ॥ ७२ ॥
कर्णेनाप्तस्य यच्चापं कृत्स्नं तद् भानुमध्यमे ।
क्रमेण प्रक्षिपेज्जह्यात् केन्द्रे मेषतुलादिगे ॥ ७३ ॥
एवं शीघ्रफलेनैव संस्कृतं रविमध्यमम् ।
बुधः स्यात् स स्फुटः, शुक्रोऽप्येवमेव स्फुटो भवेत् ॥ ७४ ॥

शीघ्रकर्णवृतेर्नेम्यां रविभुक्तकलामिते ।
धनर्णं क्रियते तत्र सर्वदा बुधशुक्रयोः ॥ ९८६ ॥
क्रान्तिमण्डलमार्गस्थं शीघ्रं नीचोच्चमण्डलम् ।
तन्नेमिस्थितनीचोच्चवृत्तं वलितमर्धशः ॥ ९८७ ॥
तन्मन्दकर्णवृत्तं च ग्रहवृत्तं च तद्वशात् ।
तन्मन्दकर्णवृत्तस्य क्रान्तिमण्डलमार्गतः ॥ ९८८ ॥
विक्षेपाद्वर्धशो मन्दस्फुटाद् विक्षेपसम्भवः ।
क्षेपकोटिश्च तत्त्रिज्यावर्गभेदात् पदं भवेत् ॥ ९८९ ॥
विक्षेपकोटिवृत्तं च क्रान्तिमण्डलपार्श्वतः ।
घटिकामण्डलस्येव द्युवृत्तं परिकल्प्यते ॥ ९९० ॥
भगोलमध्याद् विक्षेपकोटिमण्डलकेन्द्रकम् ।
शीघ्रोच्चनीचव्यासार्धेनोन्नतं क्रान्तिमार्गतः ॥ ९९१ ॥
समन्ताविष्टविक्षेपान्तरितं च प्रकल्प्यते ।
शीघ्रोच्चवृत्तं चेष्टक्षेपान्तरं तद्वदेव हि ॥ ९९२ ॥
तथा सति तु शीघ्रोच्चनीचवृत्तस्य नेमिगम् ।
विक्षेपकोटिवृत्तस्य केन्द्रमप्यवतिष्ठते ॥ ९९३ ॥
तत्राद्यं शीघ्रनीचोच्चमन्यत्तु प्रतिमण्डलम् ।
विक्षिप्ताविक्षिप्तनीचोच्चकेन्द्रान्तरजां कृतिम् ॥ ९९४ ॥
शीघ्रनीचोच्चकेन्द्रग्रहान्तरालकृतौ क्षिपेत् ।
मूलं भगोलमध्यात्तवन्तरालं ग्रहस्य तु ॥
भगोलमध्यतस्तेन विक्षेपो नीयतां बुधैः ॥ ९९५ ॥

[शुक्रे विशेषः]

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मन्दकेन्द्रभुजाजीवा खजिनांशेन संयुता ।

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मनवस्तस्य हारः स्यात्, तद्भक्ते बाहुकोटिके ॥ ७५ ॥

अविक्षिप्ते मन्दकर्णवृत्ते तत्प्रतिमण्डलम् ।
शीघ्रकर्मण्यथ क्षिप्ते ज्ञेयं तत्कोटिमण्डलम् ॥ ९९६ ॥

तन्मन्दकर्णविक्षेपवर्गयोरन्तरं पदम्[1] ।
क्षेपोऽन्त्यः कर्णवृत्तेन प्रमाय पठितस्त्विह ॥ ९९७ ॥

इष्टक्षेपोऽप्यतः कर्णस्त्रिज्यैव स्वकलामितः ।
प्रतिवृत्तमिते कर्णे तत ऊनाधिके सति ॥ ९९८ ॥

मन्दकर्णहतक्षेपस्त्रिज्याभक्तो भवेत् स्फुटः ।
विक्षेपकोटिस्तन्मन्दकर्णवर्गान्तरात् पदम् ॥ ९९९ ॥

शीघ्रोच्चनीचवृत्तं च प्रतिवृत्तकलामितम् ।
तत्कोटिफलयुक्तोनक्षेपकोट्याश्च वर्गतः ॥ १००० ॥

तद्दोःफलकृतिं युक्त्वा शीघ्रकर्णः पदं भवेत् ।
त्रिज्याघ्नं दोःफलं येन भक्तं शीघ्रविधौ स्फुटम् ॥ १००१ ॥

शीघ्रकर्णस्फुटक्षेपवर्गयोगपदं तु यत् ।
भूताराग्रहयोस्तत्तु विवरं सुस्फुटं भवेत् ॥ १००२ ॥

त्रिज्याघ्नस्फुटविक्षेपस्तेन भक्तो ह्यतिस्फुटः ।
मन्दस्फुटात् स्वपातोनाद् दोर्ज्याऽन्त्यक्षेपताडिता ॥ १००३ ॥

त्रिज्यया विहृता भूयो मन्दकर्णेन ताडिता ।
भूताराग्रहयोरन्तराप्तः क्षेपस्ततो भवेत् ॥ १००४ ॥

मन्दस्फुटाद्यो विक्षेपो यद् भूताराग्रहान्तरम् ।
तयोरानयनोपायोऽप्येवमेव ज्ञशुक्रयोः ॥ १००५ ॥

किन्तु क्षेपोऽन्तिमः शीघ्रवृत्तेन पठितस्तयोः ।
अल्पत्वान्निजवृत्तस्य शीघ्रान्त्यफलवत् सदा ॥ १००६ ॥

व्याख्या—1. A. adds here भवेत्

स्याताां, मन्दफले तस्य दोःफलं च स्वमध्यमे ।
[1]कृत्वाऽविशेषकर्णं च,[2] क्रियतां शीघ्रकर्म च ॥ ७६ ॥

ततस्त्रिज्याहतः क्षेपः[1] शीघ्रोऽन्त्यफलभाजितः ।
स भूयो मन्दकर्णघ्नस्त्रिज्ययैव समुद्धृतः ॥ १००७ ॥

तन्मन्दकर्णयोः क्षेपकोटिवर्गान्तरात् पदम् ।
तच्छीघ्रकर्णयोर्वर्गैक्यपदं भूग्रहान्तरम् ॥ १००८ ॥

क्षेपकोटीहतं शीघ्रवृत्तत्रिज्याहृतं तयोः ।
शीघ्रकर्णोऽपि तद्दोःकोटिफलक्षेपकोटिभिः ॥ १००९ ॥

[गोलसारगतं स्फुटकर्म]

गुरुभिः स्फुटकर्मेत्थं गोलसारे प्रदर्शितम् ॥ १०१० ॥

"विदितद्विहृद्भ्रमवृत्तप्रमिता ग्रहतत्तुङ्गविवरभुजा ।
वेद्यग्रहचलयोर्भूवलिप्ताभिर्मीयते, भिदा च[2] तयोः ॥ १०११ ॥

कक्ष्यामण्डलमध्यस्थमन्दवृत्तस्थबाहुकोटिभ्याम् ।
श्रुतिवृत्तप्रमिताभ्यां तन्मानेनात्र मीयते कक्ष्या ॥ १०१२ ॥

स्फुटभुजकोटिभ्यां वा परिधिव्यासार्धतोऽपि तन्मानम् ।
श्रुतिवृत्तमिदं क्षिप्तं ह्यत्रस्य[3]ग्रहवशाद् यतः क्षेपः ॥ १०१३ ॥

तत्रापि स्वप्रमितः क्षेपो, न तु योजनैः समानतया ।
तेन न[4] कर्णेनाप्यः, प्रमितः[5] स हि कक्ष्यया सदा समयः[6] ॥ १०१४ ॥

एवं कक्ष्याशीघ्रे क्षिप्तेऽस्मिन् कोटिमण्डलं च ततः ।
कर्णघ्नत्रिज्याप्तक्षेपभुजामान्दकर्णकोटिकया ॥ १०१५ ॥

मूलम्— 1. C_1 कृता for कृत्वा 2. A. C_{1-6} कर्णश्च

व्याख्या—1. A. हृतक्षेपः 2. A. भिदापि तयोः
3. A. om. स्य 4. A. B. Hapl. om. of न
5. A. कर्णेनाप्रमितः 6. A. समा समया

द्विघ्ना दोर्ज्या त्रिभज्याप्ता त्याज्या[1]ऽस्यैकोनषष्टितः ।
गुणः, सोऽपि स्फुटीकार्यो मन्दकर्णेन पूर्ववत् ।। ७७ ।।

विहगभ्रमवलयांशैरुदितात् परिधेः फलाभ्यां च ।
साध्यः कर्णस्, तेन त्रिज्याघ्ना बोःफलात्तु विवरभुजा ।। १०१६ ।।

एवमिह स्फुटसिद्धिर्द्वाभ्यामेवारजीवमन्दानाम् ।
भूग्रहविवरश्रवणे कोटिः कर्णो भुजोक्तविक्षेपः ।। १०१७ ।।

सैव भुजा त्रिज्याघ्ना भूग्रहविवरोद्धृता स्फुटः क्षेपः ।
मन्दश्रुतिनिघ्नोऽसौ मान्दः क्षेपो विभज्यतेऽनेन ।। १०१८ ।।

विदितग्रहवलयमितात् परिधेर्व्यासार्धतोऽथवा कर्णः ।
तस्य च कोटित्वेऽत्र क्षेपो मान्दो भुजा ततः स्पष्टः ।। १०१९ ।।

प्राग्वन्मन्दफलेन स्वमध्यमं स्पष्टमत्र बुधसितयोः[1] ।
तत एव च विक्षेपः पुनः स्वशीघ्रोच्चयोर्विपर्यासः ।। १०२० ।।

अल्पतया कक्ष्यायाः शीघ्राद् वृत्तात् तदाऽऽहृत्य ।
मन्दश्रुतिविक्षिप्त्योः कोट्या त्रिज्याहृतं स्फुटं तदिह ।। १०२१ ।।

क्षेपो विबुधैः पठित[2]स्त्रिज्यानिघ्नोऽन्त्यफलभाज्यः ।
भूग्रहविवरार्धमिहाप्यन्यो ग्राह्यः[3] स्फुटश्च ततः ।। १०२२ ।।

शीघ्रफलेनैव रवेः संस्कृतमिह मध्यमं स्फुटं तु तयोः ।
स्वक्षितिविवरघ्नं तद् योजनमपि केवलान्त्यफलभाज्यम् ।। १०२३ ।।

बहुकारणगतिकत्वादेवं नियता ग्रहा भगोलगताः ।
कालमेन चिदेवैषां[4] ज्ञेयः कालस्तु तद्गतिः कालात् ।। १०२४ ।।

इत्यन्योन्याश्रयताऽप्यसकृत्क्रियया निराक्रियते ।
समसमयत्वात् प्रवहभ्रमणस्यानेन ते परिच्छेद्याः ।। १०२५ ।।

मूलम्— 1. $C_{1-5\cdot10}$ शोध्या for त्याज्या

व्याख्या—1. A. सितबुधयोः 2. C. भूग्रज for पठित

3. C. ग्रह्या for ग्राह्यः 4. A. चिदेतेषां

गुणः स मन्दकर्णघ्नस्त्रिज्याप्तस्तस्य च स्फुटः ।
अशीत्याप्ते भुजाकोटी, तद्घ्ने शीघ्रफले भृगोः ॥ ७८ ॥
दोःफलं त्रिज्यया हत्वा शीघ्रकर्णहृतं भृगोः ।
चापितं भास्वतो मध्ये संस्कुर्यात् सः स्फुटः सितः ॥ ७९ ॥

घटिकापक्रम[1]मण्डलयोगश्चलतीह पूर्वपश्चिमयोः ।
रवितमसोः सूत्रेणोद्गच्छति चन्द्रोच्चतो भगोलोऽपि" ॥ १०२६ ॥
(गोलसारः, ३.१५-३०)[2]

इति ।

[ग्रहाणां स्फुटीकरणवासना]

इह विप्रतिपन्नेषु ग्रहाणां स्फुटकर्मणि ।
स्फुटद्वयेन वृत्ततुल्यास्ते यथा स्युस्तथोच्यते ॥ १०२७ ॥
स्फुटकर्म द्विधा प्रोक्तं मन्दशीघ्रविभेदतः[3] ।
मन्दान्त्यफलनीचोच्चवृत्ते भुक्तिश्च मध्यमा ॥ १०२८ ॥
प्रतिमण्डलकर्णश्च प्रतिवृत्तकलामितः ।
प्रतिमण्डलकर्णः स भिन्नरूपः प्रतिक्षणम् ॥ १०२९ ॥
त्रिज्यातुल्यस्तथाप्येषः स्ववृत्तप्रमितः सदा ।
प्रतिमण्डलकर्णान्त्यफलयोर्न्यायसाम्यतः ॥ १०३० ॥
भेदः परस्परायत्तः कृतो यत्राविशेषणात् ।
अन्त्यं फलं त्रिजीवाघ्नं तेन कर्णेन संहृतम् ॥ १०३१ ॥
प्रतिवृत्तमितं तस्मात् कर्णवृत्तमितं भवेत् ।
स्ववृत्तप्रमितः कर्णः प्रतिवृत्तकलामितात् ॥ १०३२ ॥
यावृगंशाधिकोनः स्यात् तावृगन्त्यफलं ततः ।
कर्णान्त्यफलयोर्वृद्धिक्षययोर्न्यायसाम्यतः[4] ॥ १०३३ ॥

व्याख्या—1. A. B. C. om. पक्रम, but restored from *Golasāra*.

2. The references are to the *Golasāra* of Nilakaṇṭha Somayāji, ed. by K.V. Sarma, (Hoshiarpur, 1972).

3. A. प्रभेदतः		4. C. साम्यता

येनान्योन्याश्रयत्वेन मन्दकर्णोऽविशेष्यते ।
मन्दकर्णान्त्यफलयोस्तत्र तुल्यस्वभावयोः ॥ १०३४ ॥
त्रिज्याहृतं कर्णभक्तं प्राप्यमेव फलं सदा ।
अतो[1] यथागतं मन्दफलं कार्यं तु मध्यमे ॥ १०३५ ॥

प्रतिवृत्तप्रमित्यर्थं प्राग् यत् कर्णकलामितम् ।
मन्दकर्णेन गुणितं पुरस्तात् त्रिज्ययोद्धृतम् ॥ १०३६ ॥
तद् भूयस्त्रिज्ययाभ्यस्तं कार्यं कर्णोद्धृतं ग्रहे ।
[2]तत्प्राप्यात् केवलान्मन्द[3]फलान्न तु विभिद्यते ॥ १०३७ ॥

शीघ्रनीचोच्चवृत्तस्य प्रोक्तत्वात् प्रतिमण्डले ।
मन्दकर्णे तु कर्तव्ये शीघ्रे कोटिभुजाफले ॥ १०३८ ॥

यद्वा मन्दस्फुटाच्छीघ्रोच्चोनात् कोटिभुजाफले ।
त्रिज्यया गुणिते भूयो मन्दकर्णविभाजिते ॥ १०३९ ॥
स्यातामुभे तु ते मन्दकर्ण[4]वृत्तकलामिते[5] ।
स्ववृत्तप्रमिते त्रिज्यातुल्ये कर्णे समानयेत् ॥ १०४० ॥

तत्कोटिफलयुक्तोनत्रिज्याया मृगकर्कितः ।
दोःफलस्य च वर्गैक्यात् शीघ्रकर्णः पदीकृतः ॥ १०४१ ॥

प्रतिवृत्तमिते शीघ्रबाहुकोटिफले उभे ।
त्रिज्याहृते कर्णपक्षे कर्णवृत्तमिते यतः ॥ १०४२ ॥
कर्णवृत्ते सदा त्रिज्याव्यासार्धे परिकल्पिते ।
शीघ्रदोःकोटिफलयोस्त्रिज्यागुणितयोरिह ॥ १०४३ ॥
कर्णेन हृतयोर्भेदो यः प्राप्यात्तु[6] फलद्वयात् ।
मन्दकोटीफलेनापि स तु शक्यक्रियो भवेत् ॥ १०४४ ॥
त्रिज्यातो मन्दकर्णस्य तत्कोटिफलतो भिदा ।
मन्ददोःफलवर्गेण भेदोऽस्त्यल्पो भवेद् यतः ॥ १०४५ ॥

व्याख्या—1. C. अथो
2. A. तत् प्राप्यात्
3. C. केवलं मन्द
4. A. om. कर्ण
5. B. Hapl. om. of the line.
6. A. B. प्राप्यात्

मन्दकोटिफलाभ्यस्ते शीघ्रकोटिभुजाफले ।
मन्दकर्णविभक्तेन युक्तहीने[1] उभे स्फुटे ॥ १०४६ ॥

गुणहारकयोर्भेदो मन्दकोटीफलं यतः ।
गुणहारकभेदघ्नाद् गुण्याद् हारहृतं फलम् ॥ १०४७ ॥

गुणकारेऽधिके गुण्ये क्षेप्यं हारेऽधिके त्यजेत् ।
मन्दकर्णवशादेवं तत्कोटचा नीयते भिदा ॥ १०४८ ॥

शीघ्र दोःफलतस्तत्र मन्दकोटीफलाहृतात् ।
त्रिज्यया विहृतो मन्ददोःखण्डः शीघ्रचापके ॥ १०४९ ॥

चापखण्डैस्तु यावद्भिस्तुल्यं तच्छीघ्रदोःफलम् ।
तावता[2] मन्ददोःखण्डा लभ्यन्ते नियमैक्यतः ॥ १०५० ॥

कोटिज्यात्रिज्ययोर्यादृङ् नियमस्तादृगेव हि ।
चापखण्डसमस्तज्याबाहुखण्डज्ययोरपि ॥ १०५१ ॥

मन्दकोटीफलेनातो गुणिताच्छीघ्रदोःफलात् ।
मन्दकर्णोद्धृतो भेदस्तदीयो मृदुदोःफलात् ॥ १०५२ ॥

सिध्येत् तदर्थं प्रागेव मध्यमे शीघ्रदोःफलम् ॥
पश्चान्मन्दफलं कुर्यादन्ते शीघ्रफलं तथा ॥ १०५३ ॥

मन्दकर्णवशाद् भिन्नं ततः शीघ्रफलं स्फुटम् ।
स्यादेतन्मन्दकर्णोऽत्र यदि त्रिज्यासमो भवेत् ॥ १०५४ ॥

नैवं, भेदाच्छ्रुतेर्मन्दबाहुकोटीफलद्वयात् ।
सत्यं, तथापि कर्णोऽसौ त्रिज्यातुल्यः प्रकल्प्यते ॥ १०५५ ॥

स्यादेतन्मन्दकर्णोऽत्र विदिते शीघ्रदोः पृथक्[3] ।
पृथङ्मन्दफले चापि केवले विदिते त्विदम् ॥ १०५६ ॥

तदभावे कथं कार्यमित्थं मन्दफलं बुधैः ॥
सत्यं, तथा तदज्ञानात् को दोषः, को गुणोऽन्यदा ॥ १०५७ ॥

व्याख्या—1. B. युतहीने 2. C. तावतां
3. B. Gap left for पृथक्

ननु शीघ्रफलांशस्य स्वर्णत्वं शीघ्रकेन्द्रतः ॥
न मन्दकेन्द्रवशत इति दोषो महान् भवेत् ॥ १०५८ ॥

मन्दकोटीफलायत्तस्तत्र शीघ्रफलांशकः ।
संस्कार्यः शीघ्रकर्णेन दोषोऽन्यस्तदभावतः ॥ १०५९

सत्यं, स पुनरेतावृङ्मृदुदोःफलसंस्कृतात् ।
शीघ्रदोःफलतो नीताद् दोषः प्रतिसमाहितः[1] ॥ १०६० ॥

तदेतद् विशदीकर्तुं स्फुटयुक्तिर्निरूप्यते ।
मन्दकर्णवशाद् भेदः शीघ्रबाहुफलस्य यः ॥ १०६१ ॥

कृतशीघ्रफलान्मन्दफले नीते कृतः स तु ।
यदेतन्मन्दकर्णेन ह्रियते त्रिज्यया हृतात्[2] ॥ १०६२ ॥

मन्दकोटिफलघ्नात्तन्मन्दकर्णाप्तसंस्कृतम् ।
त्रिज्याहृतं मन्दकर्णहृतं सम्पद्यते फलम् ॥ १०६३ ॥

मन्दकोटिफलं ह्यत्र त्रिज्याकर्णान्तरं यतः ।
मृदुकोटिफलाभ्यस्तत्रिज्यया चेद् विभज्यते ॥ १०६४ ॥

मन्ददोःखण्ड एव स्याच्छैघ्रदोश्चापसम्मिते ।
शैघ्रदोःफलचापं हि तत्कृत्स्नज्यात्र कल्प्यते ॥ १०६५ ॥

यादृङ्नियममाश्रित्य त्रिज्याकोटिफले स्थिते ।
तादृङ्नियमतः कृत्स्नज्यादोःखण्डौ व्यवस्थितौ ॥ १०६६ ॥

त्रिज्यैव मन्दकर्णः स्यादभेदेनात्र कल्पितः ।
ततः शीघ्रफलाभिन्नां मन्दकोटिहतां हरेत् ॥ १०६७ ॥

कृत्स्नज्यां मन्दकर्णेन मन्ददोःखण्डसिद्धये ।
कृतशीघ्रफलान्मध्यात् कृतं चेन्मन्ददोःफलम् ॥ १०६८ ॥

तत्रत्यो मन्दखण्डः स्यादित्याचार्या व्यवस्थिताः[3] ।
ततः शीघ्रफलं मन्दकर्णायत्तं भवेत् स्फुटम् ॥ १०६९ ॥

तत्र केवलमध्याद्यद् आनीतं मन्ददोःफलम् ।
कृतशीघ्रफलाद् यच्च फलयोरन्तरं तयोः ॥ १०७० ॥

व्याख्या—1. C. समाहितम् 2. Mss. हृताम्
3. C. स्याचार्यव्यवस्थिताः

मन्दकर्णवशायातं शीघ्रवृद्धिक्षयात्मकम् ।
तत् केवले शीघ्रफले कृत्वा त्रिज्याहतं पुनः ॥ १०७१ ॥

शीघ्रकर्णेन विहृतं मध्ये कार्यं यथाविधि ।
कुर्याद् गुणहरौ त्रिज्याकर्णाभ्यां वा पृथक् तयोः ॥ १०७२ ॥

योगभेदौ पुनः कार्याविति केचिद् व्यवस्थिताः ।
तत्र केवलशीघ्रस्य त्रिज्यया गुणनं पुनः ॥ १०७३ ॥

शीघ्रकर्णेन हरणं स्पष्टं परहिताविषु ।
येनेवं हरिदत्तेन[1] पठितं नियतं सदा ॥ १०७४ ॥

मन्दकर्णवशो भेदस्तत्र शीघ्रफलस्य यः ।
गुणे त्रिभगुणे तस्य शीघ्रकर्णे च हारके ॥ १०७५ ॥

शीघ्रकोट्या हतं प्राग्वद् गुणहारान्तरात्मना ।
शीघ्रकर्णेन विहृतं कुर्याच्छीघ्रफलं तु तत् ॥ १०७६ ॥

तन्मन्दफलभेदाख्यसमस्तज्यास्वरूपके ।
शीघ्रकेन्द्रेऽस्य तद्वाहुफलखण्डो भवेत् स्फुटम् ॥ १०७७ ॥

यः पुनस्तत्र मन्दश्रुत्यधीनः शीघ्रखण्डकः[2] ।
शीघ्रकेन्द्रवशान्मन्दस्फुटे कार्योऽस्य संस्कृतिः[3] ॥ १०७८ ॥

न मन्दकेन्द्रवशतस्तस्य युक्ता धनर्णता ।
नैतन्मन्दश्रुतिवशात् क्रियमाणो न युज्यति ॥ १०७९ ॥

यथा हि[4] मन्दकर्णोत्थः शीघ्रवृद्धिक्षयात्मकः[5] ।
स पुनर्मन्दकर्णस्य त्रिज्योनाधिकतावशात् ॥ १०८० ॥

धनर्णभूतोऽसौ मन्दकेन्द्रे कर्किमृगादिगे ।
स तु प्राकृतशीघ्रस्य कृते[6] मन्दफले कृतः ॥ १०८१ ॥

तथाहि धनभूतं तद्यदा शीघ्रफलं भवेत् ।
तन्मेषादौ मन्दफले मन्दकर्णमहत्त्वतः ॥ १०८२ ॥

व्याख्या—1. B. हरदत्तेन
2. C. खण्डतः
3. A. B. संहृतिः
4. C. तथा हि
5. A. क्षयापहः
6. A. कृतो

तदायत्तं शीघ्रफलं स्वल्पं स्यादन्यशीघ्रतः ।
मन्दकोटयागतं शीघ्रफलं त्याज्यं स्वमध्यतः ॥ १०८३ ॥

त्याज्यं मन्दफलं चापि तद्योगस्त्यज्यते ततः ।
ततो[1] मन्दवशात् तस्माच्छीघ्रस्योक्ता धनर्णता ॥ १०८४ ॥

कर्क्यादिगे मन्दकेन्द्रे तत्कर्णस्याल्पतावशात् ।
मन्दकोटयागतं शीघ्रफलं स्यादन्यतो महत् ॥ १०८५ ॥

धनं यद्यपि तन्मन्दकेन्द्रकोटयात्मके सति ।
ऊर्ध्वोर्ध्वं तद्भुजाल्पत्वाद् धनत्वे पर्यवस्यति ॥ १०८६ ॥

तुलादौ मन्दकर्णस्य स्वल्पत्वाच्छीघ्रजं[2] महत् ।
मान्दं धनं च तत्केन्द्रात् ततोऽत्रापि धनर्णता ॥ १०८७ ॥

मन्दकेन्द्रात् ततस्तत्राप्युचिता तद्धनर्णता ।
मृगादौ मन्दकर्णस्य महत्वाच्छैघ्रमल्पकम् ॥ १०८८ ॥

कोटित्वान्मृदुकेन्द्रस्य धनत्वेऽपि फलत्यृणम् ।
मन्दकेन्द्राद्धनर्णत्वमेवं शीघ्रफलेऽप्यृणे ॥ १०८९ ॥

अतः शीघ्रफलं पूर्वं कार्यं केवलमध्यमे ।
अतो मन्दफलं मध्ये केवले शीघ्रजं ततः[3] ॥ १०९० ॥

कृतमान्दे तु कर्तव्यं इति खेटस्फुटत्रयात् ।
मन्दकर्णोऽथ[4] तत्त्रिज्यायोगार्धं कल्प्यते यदा ॥ १०९१ ॥

मन्दकोटीवलं तत्र गुणकारोऽथ, हारकः ।
कर्णत्रिज्यायुतिदलं, सर्वमन्यत्तु पूर्ववत् ॥ १०९२ ॥

तत्र शीघ्रवलं कृत्वा[5] पुनर्मन्दफलं नयेत् ।
मध्यकोटयर्धवशतः शीघ्रवृद्धिक्षयौ यतः[6] ॥ १०९३ ॥

अतः शीघ्रफलस्यार्धं क्रियते प्राक् तु मध्यमे ।
यदा मन्दश्रुतिस्त्रिज्यामेवार्धवशतो द्वयोः ॥ १०९४ ॥

व्याख्या—1. B. Gap for ततो
2. A. शीघ्रगं
3. A. तथा
4. C. मन्दकर्णेऽथ
5. C. भूत्वा
6. A. B. ततः

[ग्रहाणां दिनभुक्त्यानयनम्]

श्वस्तनेऽद्यतनाच्छुद्धे वक्रभोगोऽवशिष्यते ।
विपरीतविशेषोत्थश्चारभोगस्तयोः स्फुटः ॥ ८० ॥

स्यातां वृद्धिक्षयौ मन्दशीघ्रनीचोच्चवृत्तयोः ।
तदा मन्दफलं शीघ्रफलं च त्रिज्यया हते ॥ १०९५ ॥

हरेन्मन्दभुक्तित्रिज्यायोगार्धेन फले स्फुटे ।
स्यातामुभे यतो मन्दकर्णवृत्तकलामिते ॥ १०९६ ॥

तत्र मन्दफलं मध्ये कर्तव्यं शीघ्रजं पुनः ।
त्रिज्याकोटिफलाभ्यां तत्कर्णानयनपूर्वकम् ॥ १०९७ ॥

त्रिज्यया निहतं कर्णभक्तं चापीकृतं पुनः ।
कृतमान्दे तु कर्तव्यमेवं सिद्ध्येत् स्फुटद्वयात् ॥ १०९८ ॥

मन्दकर्णोत्थसंस्कारानपेक्षं वा फलद्वयम् ।
चापीकृत्य पठेत् ताभ्यां कुर्यात्, स्फुटचतुष्टयम् ॥ १०९९ ॥

मान्दार्धं मध्यमे कुर्यान्नीतं शीघ्रदलं ततः ।
मध्यमे कृतमान्दार्धे[1] कृत्स्नं मन्दफलं ततः ॥ ११०० ॥

आनीतकेवले मध्ये कुर्याच्छीघ्रफलं ततः ।
कृत्स्नं तत्कृतमान्दे तु सिद्ध्यत्येवं स्फुटग्रहः ।
अत एवोक्तमाचार्यैरित्थं स्फुटचतुष्टयम् ॥ ११०१ ॥

श्वस्तन इति (80)— स्पष्टम्

इत्येव परक्रोडावासद्विजवरसमीरितो योऽर्थः ।
स तु तन्त्रसंग्रहस्य प्रोक्तोऽध्यायो द्वितीयोऽभूत् ॥ ११०२ ॥

[इति तन्त्रसंग्रहस्य पद्यव्याख्यायां युक्तिदीपिकायां
स्फुटप्रकरणं नाम
द्वितीयोऽध्यायः[2] ॥]

व्याख्या—1. A. C. मन्दार्धे

2. A. C. om. the colophon. B. reads : इति तन्त्रसंग्रहव्याख्यायां द्वितीयोऽध्यायः ।

अथ तृतीयोऽध्यायः

छायाप्रकरणम्

[शङ्कुस्थापनम्]

शिलातलेऽपि वा भूमौ समायां मण्डलं लिखेत् ।
तन्मध्ये स्थापयेच्छङ्कुं कल्पितं द्वादशाङ्गुलम् ॥ १ ॥

[मङ्गलाचरणम्]

यत्सेवनतः सद्यो लभते मूकोऽपि वावदूकत्वम् ।
कर्पूरामलगात्रीं सरस्वतीं तां नमस्यामि ॥ १ ॥

अर्कादीनां स्फुटविधिमित्थं प्रोच्य सविस्तरम् ।
अथाध्यायान्तरं वक्ष्ये दिक्कालादिप्रसाधकम् ॥ २ ॥

शिलातले इत्यादि (1-7a)

[भू-वायु-राशि-गोलसंस्थानम्]

"समघनवृत्ता भूमिः स्वयैव शक्त्या धृता मृदादिमयी ।
ज्योतिर्गोलकमध्ये बिभर्ति विश्वं समन्ततो वस्तु ॥ ३ ॥

द्रव्याणि गुरूणि यतः पतन्ति भूमौ समन्ततो नभसः ।
अध एव सर्वतो भूस्तस्मात् प्रतियोगिनी विगूर्ध्वाख्या ॥ ४ ॥

कतिपययोजनपरिमितम् अतः समन्ताद् विहायसि विहायः ।
भ्रमति ह्यूर्ध्वं वायुः प्रवहाख्यो भ्रामयन् विहगान् ॥ ५ ॥

तत्र भ्रमन्ति यत्र क्रमेण दृश्यानि भानि सर्वाणि ।
पार्श्वस्थे ध्रुवतारे[1] निरक्षसंज्ञो भुवि प्रदेशः सः ॥ ६ ॥

व्याख्या—1. A. पार्श्वस्थध्रुवतारे

घटिकामण्डलमाहुस्तत्र यदधऊर्ध्वगं भ्रमद् वृत्तम् ।
अभितोऽपि च तद् भ्रमतां भवन्ति नाना ध्रुवा द्युवृत्तानि ॥ ७ ॥

प्रत्यग् भ्रमति भचक्रं मेधीकृत्य ध्रुवौ नियतम् ।
चक्रकलासमसंख्यैः प्रवहेण भ्राम्यते च तत् प्राणैः ॥ ८ ॥

द्वादशराशिविभक्तो भगोल इह, तस्य मध्यवलयं यत् ।
अपयातं घटिकाख्याद् तदर्धशः सौम्ययाम्यदिशोः ॥ ९ ॥

तत्समतिर्यग्वलयैः प्रविभज्यन्तेऽत्र राशिभागकलाः ।
यत्र क्वापि च दृष्टं ज्योतिर्मेषादिराशिगं तस्मात् ॥ १० ॥

लग्नव्यवहारस्तु भ्रमद्भगोलस्थमध्यवृत्तवशात् ।
स्वाधिष्ठितात् तथोद्यति भिन्ने राशावुदूदयोऽपि भवेत्" ॥ ११ ॥

(गोलसारः, २.१-६)

"प्रत्यग् भ्रमतां तेषां दिनार्धवलूप्त्यै प्रकल्प्यते स्थायि ।
वलयमुदग्दक्षिणतः समपार्श्वस्थं च दिवसनिशोः ॥ १२ ॥

एवं निरक्षदेशजमुन्मण्डलमवनिजं ततोऽन्यत्र ।
सममण्डलमपि भिन्नं घटिकावृत्तात् स्वदेशवशात्" ॥ १३ ॥

(गोलसारः, २.१४-१५)

"घटिका[पक्रम][1]मण्डलयोश्चलतीह पूर्वपश्चिमयोः ।
रवितमसोः सूत्रेणोद्गच्छति चन्द्रोच्चतो भगोलोऽपि" ॥ १४ ॥

(गोलसारः, ३.३०)

इति भू-वायु-राशीनां गोलसंस्थानमीरितम् ।
क्रान्तिमण्डलतो याति प्राङ्मुखं भास्करोऽन्वहम् ॥ १५ ॥

अपक्रान्तं च घटिकावृत्तात् तत्सौम्ययाम्ययोः ।
समोपरि निरक्षेषु घटिकामण्डलं भवेत् ॥ १६ ॥

समतिर्यग्गतं तस्माद् दक्षिणोत्तरमण्डलम् ।
चतसृष्वपि दिक्ष्वन्यन्मण्डलं स्वस्तिकोज्ज्वलम् ॥ १७ ॥

व्याख्या—1. A. B. C. om. पक्रम, which has been restored from *Golasāra*.

[पूर्वापररेखा]

तच्छायाग्रं स्पृशेद्यत्र वृत्ते[1] पूर्वापराह्णयोः ।
तत्र बिन्दू निधातव्यौ वृत्ते पूर्वापराभिधौ ॥ २ ॥

भेदात् पूर्वापरक्रान्त्योश्छायाकर्णाङ्गुलाहतात् ।
लम्बकाप्तं पूर्वबिन्दोर्नीत्वा कार्योऽत्र सोऽयनात् ॥ ३ ॥

[याम्योत्तरादिरेखाः]

मध्यं कृत्वा तयोर्बिन्द्वोस्तुल्ये वृत्ते समालिखेत् ।
तत्संश्लेषोत्थमत्स्येन ज्ञेये याम्योत्तरे दिशौ ॥ ४ ॥

निरक्षे घनभूमध्यपार्श्वस्थं क्षितिजं भवेत् ।
दक्षिणोत्तरसम्पातद्वये यस्य ध्रुवौ स्थिरौ ॥ १८ ॥

ऊर्ध्वस्थात् स्वस्तिकाद् याम्ये सौम्ये चाधोगतावपि ।
चतुर्विंशतिभागान्ते भवति क्रान्तिमण्डलम् ॥ १९ ॥

भिद्यते येन वृत्तेन प्राक् पश्चात् स्वस्तिकद्वयम् ।
सौम्यगोलोऽस्य सौम्यार्धं याम्यगोलस्तथेतरत् ॥ २० ॥

मध्ये सौम्यायनं यस्य घटिकावृत्तसंयुतिः ।
मध्ये याम्यायनं चान्या राशिषट्कं यदन्तरम् ॥ २१ ॥

घटिकावृत्तमार्गेण भ्राम्यति प्रवहोऽन्वहम् ।
पश्चान्मुखः समजवो ग्रहर्क्षाणि समीरयन् ॥ २२ ॥

[दिगवगमनप्रकारः]

तत्रायनवशात् सौम्ययाम्ययोर्गच्छतो रवेः ।
समपूर्वापरे स्यातां छायाग्रे नेष्टमण्डले ॥ २३ ॥

प्रवेशनिर्गसमयक्रान्तिभेदेन भेदतः ।
भिन्नकालरविक्रान्तिविवरोत्थे फले कृते ॥ २४ ॥

मूलम्— 1. A. वृत्तं

तद्वृत्तमध्यमत्स्येन पूर्वापरदिशावपि ।
दिङ्मध्यमत्स्यसंसाध्याश्चतस्रो विदिशोऽपि च ॥ ५ ॥

[अधऊर्ध्वदिगवगमनम्]

अधऊर्ध्वदिशौ ज्ञेये लम्बकेनैव नान्यथा ॥ ६a ॥

शक्या कल्पयितुं तत्र समपूर्वापरस्थितिः ।
इष्टमण्डलनेमिस्थच्छायाप्राङ्गुलवर्गतः ॥ २५ ॥

तच्छङ्क्वङ्गुलवर्गाढ्या छायाकर्णपदं भवेत् ।
छायाकर्णहतं कालद्वितयापक्रमान्तरम् ॥ २६ ॥

लम्बकेन हरेल्लब्धं तद्वृत्ते क्रान्तिजं फलम् ।
तेनायनवशान्नेयं प्राच्यां छायाग्रमत्र तु ॥ २७ ॥

अयनव्यत्ययात् पश्चाच्छायाग्रं वाथ मण्डले ।
समपूर्वापरं येन छायाग्रद्वितयं भवेत् ॥ २८ ॥

छायाग्रद्वितयस्पृष्टं सूत्रं प्रागपरं ततः ।
समतिर्यग्गतं सूत्रं ततः स्याद् दक्षिणोत्तरम् ॥ २९ ॥

ननु लम्बेन सिद्धेन कर्तव्यं क्रान्तिजं फलम् ।
विषुवद्दिनमध्याह्नच्छायातोऽप्यक्षलम्बकौ ॥ ३० ॥

तयोर्लम्बाक्षयोः सिद्धिर्दिक्परिच्छेदपूर्विका ।
स पुनर्लम्बकाधीननिजक्रान्तिफलान्तरात् ॥ ३१ ॥

इति यत्तदुपायेऽस्मिंश्चक्रप्रस्ततया भवेत्[1] ।
ततोऽयनान्ते मध्याह्ने दिनपूर्वापराह्णयोः ॥ ३२ ॥

तुल्यकालान्तरितयोः समपूर्वापरं भवेत् ।
छायाग्रद्वितयं क्रान्तिफलेनैवान्यदा सदा ॥ ३३ ॥

मामामस्तोदयाभ्यां वा समपूर्वापरे दिशौ ।
ज्ञातव्ये[2] तद्विपर्यस्तसूत्रतो दक्षिणोत्तरे ॥ ३४ ॥

व्याख्या—1. A. चक्रकप्रस्तका भवेत्　　　2. A. यातव्ये

[विषुवच्छाया]

एकसूत्रगता[1] च्छाया यस्मिन्नह्न्युदयास्तयोः ॥ ६b ॥

मध्याह्ने विषुवाख्यः स्यात् कालस्तस्मिन् दिने यतः ।
तस्मात् तद्दिनमध्याह्नच्छाया वैषुवती मता ॥ ७ ॥

सूत्राधंतोऽधिकव्यासतदग्रस्थितकेन्द्रयोः ।
वृत्तयोर्नेमिसम्पातद्वितयाज्जायते झषः ॥ ३५ ॥

व्यस्तसूत्रं भवेत्तस्य मुखपुच्छविनिस्सृतम् ।
दिशश्चतस्रो विज्ञेयास्ततोऽन्या विदिशोऽपि च ॥ ३६ ॥

गुरुद्रव्यनिबद्धाग्रं सूत्रं यत्रावलम्ब्यते[1] ।
यतो वा तद्वशाद् वेद्यैवाधऊर्ध्वदिशोः स्थितिः ॥ ३७ ॥

इति ।

[विषुवच्छायावासना]

एकसूत्रगतेति (6b-7)—

क्रान्त्योर्भिन्नदिशोः साम्यं सायनास्तोदयार्कयोः ।
यस्मिन्नहनि तत्रार्को मध्याह्ने विषुवं व्रजेत् ॥ ३८ ॥

मान्यदास्तोदयक्रान्त्योर्विदिशोर्भवसम्भवात् ।
एकसूत्रगता च्छाया तत्र स्यादुदयास्तयोः ॥ ३९ ॥

इष्टशङ्कोर्यतः केन्द्रं सूत्रेऽस्मिन् प्रतितिष्ठति ।
तत्र मध्यन्दिनच्छाया कथ्यते विषुवत्प्रभा ॥ ४० ॥

छायाशङ्कू भुजाकोट्यौ तत्र कर्णं ततो नयेत् ।
अक्षलम्बकयोः सिद्धिस्तैस्त्रिज्याकर्णतो भवेत् ॥ ४१ ॥

इति ।

मूलम्— 1. B, एकरसूत्र ; $C_{2-6\cdot 8-9}$ एतत्सूत्र

व्याख्या—1. A. लम्बते

[छायाशङ्कुकर्णानां सम्बन्धः]

तच्छङ्कुवर्गसंयोगमूलं कर्णोऽस्य वर्गतः ।
त्यक्त्वा शङ्कुकृतिं, मूलं छायाशङ्कुर्विपर्ययात् ॥ ८ ॥
ज्ञेयो दोःकोटिकर्णेषु द्वाभ्यामन्योऽखिलेष्वपि ॥ ९a ॥

[अक्षो लम्बश्च]

छायां तां त्रिज्यया हत्वा स्वकर्णेन हरेत्, फलम् ॥ ९b ॥
अक्षजीवा, तथा शङ्कुं कृत्वा लम्बकमानयेत् ॥१०a॥

तच्छङ्कुवर्गेति (8-11)—

[शङ्कु-च्छाया-कर्णयोः सम्बन्धः]

समतिर्यग्गतत्वेन च्छायाशङ्क्वोः परस्परम् ।
दोःकोटिरूपता, कर्णस्तयोर्वर्गयुतेः पदम् ॥ ४२ ॥

दोःकर्णयोर्वर्गभेदाद् यदि वा कोटिकर्णयोः ।
मूलं कोटिभुजा[वित्थं][1] द्वाभ्यां तदितरोऽन्यः ॥ ४३ ॥

[दृग्गोलच्छायातः अक्षलम्बकौ]

त्रिज्यया विषुवच्छायां शङ्कुं च द्वादशाङ्गुलम् ।
निहत्य विषुवत्कर्णेनोद्धृतावक्षलम्बकौ ॥ ४४ ॥

[दृग्गोलाक्षलम्बकयोः भगोलापादनम्]

भूव्यासार्धं हि दृग्ज्यायां[2] त्रिज्यायां लम्बयोजनम्[3] ।
कियत्तदिष्टदृग्ज्यायां स्वकक्ष्यायां भवेत् तदा ॥ ४५ ॥

इत्थं त्रैराशिकात् कल्प्यं दृग्ज्यालम्बनयोजनम् ।
मध्ययोजनकर्णेन त्रिज्यातुल्याः कला यदि ॥ ४६ ॥

इष्टयोजनलम्बेन कियत्यस्तत्कलास्तदा ।
स्फुटभुक्त्या हतास्ताश्च मध्यभुक्त्या विभाजिताः ॥ ४७ ॥

व्याख्या—1. A. C. वर्थं ; B. वर्धं 2. A. दृश्यायां; B. C. दृश्याया
3. A. Hapl. om. of two lines after योजनम्

[भगोले अक्षज्या लम्बज्या च]

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अक्षज्यार्कगतिघ्नाप्ता खस्वराद्र्येकसायकैः ॥ १०b ॥
फलोनमक्षचापं स्यादर्कबिम्बार्धसंयुतम् ।
स्फुटं, तज्ज्याक्षजीवापि, तस्याः कोटिश्च लम्बकः ॥ ११ ॥

स्फुटलम्बनलिप्ताः स्युरिति त्रैराशिकत्रयात् ।
हारो गुणश्च त्रिज्यैका तयोराद्यद्वितीययोः ॥ ४८ ॥

मध्ययोजनकर्णश्च मध्यभुक्तिश्च हारकौ ।
अन्ययोर्गुणकस्त्वाद्ये तद्भूव्यासार्धयोजनम् ॥ ४९ ॥

गुणकारहते हारे हार एवात्र नो गुणः ।
मध्ययोजनकर्णघ्नमध्यभुक्तेस्ततो हृतः ॥ ५० ॥

नियतैरेव लम्बार्थं भूव्यासार्धस्य योजनैः ।
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स एव हारकः खस्वराद्र्येकेषुमितो मतः ॥ ५१ ॥

स्फुटभुक्तिर्गुणो याभ्यां दृग्ज्यातः स्फुटलम्बनम् ।
घनभूमध्यपार्श्वस्थं सर्वत्र क्षितिजं भवेत् ॥ ५२ ॥

उन्नतज्या ततः शङ्कुस्तद्भुजा महती प्रभा ।
भूपृष्ठगामिनः शङ्कोश्छाया स्याल्लम्बिता ततः ॥ ५३ ॥

भूव्यासार्धविहीनोऽसौ शङ्कुर्भूपृष्ठतो[1]ऽन्यतः ।
छाया च वर्धते त्रिज्याकर्णे कोटिभुजत्वतः ॥ ५४ ॥

तल्लम्बनवशात् तस्या यवाधिक्यं भवेदिह ।
दृक्सिद्धायास्त्यजेत् तत्तु च्छाया येन भगोलगा ॥ ५५ ॥

तत्त्रिज्यावर्गविश्लेषमूलं शङ्कुश्च कोटिका ।
बिम्बोर्ध्वनेम्याः प्रसृता रश्मयः क्रशयन्ति भाम् ॥ ५६ ॥

बिम्बव्यासार्धनिष्पन्नशङ्कुखण्डेन भास्वतः ।
वर्धयन्ति च दोःखण्डाः शङ्कुं भूपृष्ठवर्तिनम् ॥ ५७ ॥

व्याख्या—1. A. भूपृष्ठगो

[सममण्डलं उन्मण्डलं अग्रा च]

पूर्वापरायता रेखा प्रोच्यते सममण्डलम् ।
रेखा प्राच्यपरा साध्या विषुवद्भाग्रगा तथा ॥ १२ ॥

उन्मण्डलं च विषुवन्मण्डलं साभिधीयते ।
इष्टच्छायाग्रतद्रेखाविवरं त्वग्रसंज्ञितम् ॥ १३ ॥

बिम्बस्य घनमध्यान्तो भवेच्छङ्कुर्यतोऽपरः ।
फलयोरन्तरं शङ्कुच्छाययोस्तद्वृणं धनम् ।
प्रत्यक्षसिद्धयोर्बिम्बघनमध्यगतौ यतः ॥ ५८ ॥

इति ॥

[सममण्डलं, उन्मण्डलं अग्रा च]

पूर्वापरायतेति (12-13)—

विषुवद्भाहताच्छङ्कोः शङ्क्वग्रं द्वादशोद्धृतम् ।
द्वादशघ्नात् ततः शङ्कूद्धृतं यल्लभ्यते फलम् ॥ ५९ ॥

शङ्कोर्द्वादशसंख्यस्य शङ्क्वग्रं तत् सदा समम् ।
द्वादशघ्नो महाशङ्कुर्यत्र हारो गुणोऽपि च ॥ ६० ॥

अतोऽत्र विषुवच्छायैवैका शङ्क्वग्रमिष्यते ।
छायाभुजैकदेशत्वं यस्य तूपरि वक्ष्यते ॥ ६१ ॥

द्रष्टुः पूर्वापरा रेखा प्रोच्यते सममण्डलम् ।
तस्यास्तु विषुवद्भाग्रे रेखा पूर्वापरापरा ॥ ६२ ॥

उन्मण्डलं च विषुवन्मण्डलं साभिधीयते ।
इष्टच्छायाग्रविषुवद्रेखाभेदोऽग्रसंज्ञितः ।
एतत्त्रयोपयोगस्तु च्छायाभ्रमणकर्मणि ॥ ६३ ॥

इति ॥

[लङ्कोदयप्राणाः स्वदेशराश्युदयप्राणाश्च]

राश्यन्तापक्रमैः कोटिः प्राणाः प्राग्वच्चरासवः ।
प्राणान् लङ्कोदयान् प्राहुः स्वोदयाश्चरसंस्कृताः ॥ १४ ॥

राश्यन्तापक्रमैरिति (14-16a)—

[लङ्कोदयप्राणवासना]

याम्यायनान्तक्षितिजसम्पाताक्रान्तनेमिकम् ।
घटीवृत्ततिरश्चीनं तद्ध्रुवद्वयसङ्गतम्[1] ॥ ६४ ॥

तिर्यग्वृत्तं तु तत् तस्य क्षितिजेन तु संयुतौ ।
सौम्यायनाद्यभाद्यंशो युगपत् तद्द्वयं स्पृशेत् ॥ ६५ ॥

प्रवहप्रेरणाद् राशेर्नित्यः प्रत्यङ्मुखं यतः ।
राशेरन्त्योंऽशको नैव युगपत् तद्द्वयं स्पृशेत् ॥ ६६ ॥

तिर्यग्वृत्तस्य संस्पर्शात् प्राग्यतः क्षितिजं स्पृशेत् ।
क्षितिजस्य नतत्वेन तिर्यग्वृत्तादुदङ्मुखम् ॥ ६७ ॥

तिर्यग्वृत्ते तु भाद्यन्ते स्पर्शकालोत्थमन्तरम् ।
लङ्कोदयासवस्ते स्युः क्षितिजे स्वोदयासवः ॥ ६८ ॥

[स्वदेशराश्युदयप्राणवासना]

तिर्यग्वृत्तस्थसंस्पर्शात् प्रागेव क्षितिजस्पृशः ।
भान्तस्य तद्द्वयस्पर्शान्तरं स्वचरखण्डतः ॥ ६९ ॥

अतोऽयनाद्यराशेस्तु येऽमी लङ्कोदयासवः ।
हीनाः स्वचरखण्डेन ते स्वदेशोदयासवः ॥ ७० ॥

एवं सौम्यायनान्तानां ये तु लङ्कोदयासवः ।
ते स्वस्वचरखण्डोना राशीनां स्वोदयासवः ॥ ७१ ॥

याम्येऽयने च राशीनां ये स्युर्लङ्कोदयासवः ।
ते स्वस्वचरखण्डेन युताः स्युः स्वोदयासवः ॥ ७२ ॥

सौम्ययाम्यायनगतराशीनां व्यत्ययात् स्थितेः ।
चरखण्डैः स्वकैः शुद्धिक्षेपौ कार्यौ विपर्ययात् ॥ ७३ ॥

व्याख्या—1. B. नं ध्रुवद्वयसमुद्गतम्

चरमाद्यन्त्ययोः शोध्यं पदयो,र्योज्यमन्ययोः ।
एवंकृतास्तु विश्लिष्टा राशीनामुदयासवः ॥ १५ ॥
ओजयोस्तु क्रमेणैव, युग्मयोरुत्क्रमेण च ॥ १६a ॥

तिर्यग्वृत्तस्थभाद्यन्तस्पर्शकालोत्थमन्तरम् ।
लङ्कोदयासवो यत्तत् क्षितिजे स्वोदयासवः ॥ ७४ ॥

तिर्यग्वृत्तक्षितिजयोर्भान्तस्पर्शान्तरं चरम् ।
यदा तज्ज्या द्युवृत्तस्था घटीवृत्तमिता भवेत् ॥ ७५ ॥

द्युज्या तदा चरज्या तु द्युवृत्तप्रमिता भवेत् ।
याम्यायनान्तक्षितिजसम्पातस्पृष्टनेमिकम् ॥ ७६ ॥

घटीवृत्ततिरश्चीनं ध्रुवद्वितयसङ्गतम् ।
वृत्तं यद्यदि तत्रैव राशयो दक्षिणायने ॥ ७७ ॥

कार्त्स्न्येनोद्यन्ति तत्तेषां कालो लङ्कोदयासवः ।
न त्वेवं क्षितिजे तेषामुदयास्तमयौ यतः ॥ ७८ ॥

सौम्यायनान्तात् क्षितिजं क्रमेणोर्ध्वस्थितं निजम् ।
याम्यायनान्तात् क्षितिजं क्रमेणाधोगतं तथा ॥ ७९ ॥

प्रत्येकं स्वचरप्राणयुक्तैर्लङ्कोदयासुभिः ।
उद्यन्ति राशयः साक्षे ततो याम्येऽखिला भवेत् ॥ ८० ॥

तदाश्रितानां नक्षत्रग्रहाणामपि तद्वशात् ।
विविधेषु द्युवृत्तेषु तुल्यकालो भ्रमो भवेत् ॥ ८१ ॥

तिर्यग्वृत्तभ्रमवशाद् द्युवृत्तभ्रमणं यतः ।
ग्रहर्क्षाणां च सर्वेषां भ्रमतां स्वद्युवृत्ततः ॥ ८२ ॥

कालवृत्तान्यमन्तानि घटिकावृत्तपार्श्वयोः ।
तेषां मिथो विभिन्नानां प्रवहप्रेरणात् सदा ॥ ८३ ॥

क्रान्तिमण्डलपातेषु भ्रमकालः समो भवेत् ।
तद्भागेषु तु सर्वत्र भिन्नकालो भ्रमो भवेत् ॥ ८४ ॥

क्रान्त्यन्तरद्युवृत्तेषु तद्दोर्ज्याभागभेदतः ।
घटिकामण्डले कृत्वा तच्चापीकरणे सति ॥ ८५ ॥

निरक्षेऽपि राश्यादेः कालभेदो भवेत् स्फुटम् ।
चरमप्यपरं साक्षे तद्भेदाय विजृम्भते ॥ ८६ ॥

स्वदेशक्षितिजं यस्मादुदगुन्मण्डलान्नतम् ।
दक्षिणेनोन्नतं[1] यस्माद् व्यस्तत्वं गोलयोर्मिथः ॥ ८७ ॥

चरं द्युवृत्तप्रमितं यदन्तरधनुर्भवेत्
क्षितिज्या घटिकावृत्तप्रमिता धनुषोऽस्य तु ॥ ८८ ॥

भिन्नास्ते स्वचरप्राणैस्ततः साक्षनिरक्षयोः ।
सौम्यायने तु सौम्याग्रं राशीनां क्षितिजे स्वके ॥ ८९ ॥

निरक्षोदयतः प्रागेवोदेति स्वचरासुभिः ।
उन्मण्डलक्षितिजयोस्तत्र तावन्मितेऽन्तरे ॥ ९० ॥

प्रवहप्रेरणात् प्राच्यामुद्गच्छत्क्रान्तिमण्डलम् ।
आधारस्यवृत्तसम्पातं प्रागेव कुरुते ततः ॥ ९१ ॥

पश्चादेवोर्ध्ववृत्तेन चरप्राणा यदन्तरम् ।
याम्यायने च याम्याग्रं राशीनां स्वैश्चरासुभिः ॥ ९२ ॥

निरक्षोदयतः पश्चादुदेति क्षितिजे स्वके ।
अतो लङ्कोदयासुभ्यः त्यज्यन्ते स्वचरासवः ॥ ९३ ॥

सौम्येऽयनेऽन्यथा याम्ये स्वोदयप्राणसिद्धये ।
तत आद्यन्तपदयोर्निरक्षोदयमानतः ॥ ९४ ॥

शोधनं स्वचरासूनां पदयोर्मध्ययोर्युतिः ।
क्रान्तिवृत्तेष्टदोर्ज्यायाः कोटिज्याया द्युमण्डले ॥ ९५ ॥

सैव लङ्कोदयप्राग्ज्या घटिकामण्डले कृते ।
चापीकृता च सा वृत्ते तस्मिन् लङ्कोदयासवः ॥ ९६ ॥

क्रान्तिवृत्तेष्टदेशस्य तैः प्राणैरुदयो यतः ।
क्रान्तिमण्डललिप्तास्यस्तत्प्राणानां यदन्तरम् ॥ ९७ ॥

व्याख्या—1. A. B. दक्षिणे चोन्नतं

[इष्टशङ्कुः छाया च]

प्राक्कपाले गतान् प्राणान्, गम्यान् मध्यदिनात्[1] परम् ॥ १६b ॥

तदेव कालसिद्ध्यर्थं कार्यं प्राणकलान्तरम् ।
निरक्षदेशे साक्षे तु कार्यास्तत्र चरासवः ॥ ९८ ॥

युग्मौजपदयोः स्वर्णं भवेत् प्राणकलान्तरम् ।
चरप्राणाः क्रान्तिवृत्तगोलयोर्याम्यसौम्ययोः ॥ ९९ ॥

घटिकामण्डलप्राणक्रान्तिवृत्तकलान्तरम् ।
युक्तं हीनं[1] चरप्राणैः सौम्ये याम्ये तथायने ॥ १०० ॥

कालक्षेत्रान्तरं स्वर्णं गोलयोर्याम्यसौम्ययोः ।
केवलं क्षितिजे कार्यं क्षेत्रात् कालप्रसिद्धये ॥ १०१ ॥

नतोन्नतत्वात् तत्रैव क्षितिजस्थचरासुभिः ।
क्रान्तिमण्डलतिर्यक्त्वं केवलं दक्षिणोत्तरे ॥ १०२ ॥

क्रान्तिवृत्तेष्टदोर्ज्यायाः कोटिज्याया द्युमण्डले ।
तामिमां घटिकावृत्ते कृत्वा चापीकृतासुभिः ।
मध्यकालो भवेत् तेन मध्यलग्नं तथा नयेत् ॥ १०३ ॥

इति ।

[गतगन्तव्यप्राणैः महाशङ्कुच्छायानयनवासना]

प्राक्कपाले इति (16b-19a)—

ज्यार्धानां निजपार्श्वस्थवृत्तसम्पातमूलता ।
मिथो दोःकोटिरूपाणां वृत्तेषु निखिलेष्वपि ॥ १०४ ॥

वृत्तयोर्विप्रकर्षश्च ज्यया नैव प्रमीयते ।
उन्मण्डलद्युवृत्तानां समपार्श्वगतं भवेत् ॥ १०५ ॥

मूलम्—1. A, मध्यन्दिनात्

व्याख्या—1. B. युक्तहीनं

विन्यस्यार्कचरप्राणाः शोध्या मानावुदग्गते ।
योज्या दक्षिणगे, तेभ्यो जीवा ग्राह्या यथोदितम् ॥ १७ ॥
व्यस्तं कृत्वा चरज्यां च द्युज्याघ्नां त्रिज्यया हरेत् ।
लम्बकघ्नात् फलात् त्रिज्याहृतः शङ्कुर्विवस्वतः ॥ १८ ॥
तत्त्रिज्याकृतिविश्लेषान्मूलं छाया महत्यपि ।

न तु स्वदेशक्षितिजं तयोर्भेदात् क्षितिज्यया ।
ज्यार्धानां तद्द्युवृत्तोन्मण्डलसम्पातमूलतः ॥ १०६ ॥

द्युवृत्तात् क्षितिजस्पृष्टादुन्नतज्या विवक्षिता ।
क्षितिज्ययाधिकोना सा गोलयोः[1] सौम्ययाम्ययोः ॥ १०७ ॥

द्युवृत्तात् क्षितिजस्पृष्टात् तत एवोन्नतासवः ।
चरप्राणोनसंयुक्ता गोलयोः सौम्ययाम्ययोः ॥ १०८ ॥

द्युवृत्तोन्मण्डलस्पर्शावधित्वार्थं प्रकल्पिताः ।
ज्यार्धानामिह सर्वेषां तत्प्रवृत्तेः सपार्श्वतः ॥ १०९ ॥

क्षितिजावधिकत्वाय चरज्या तद्विपर्ययात् ।
द्युवृत्तोन्नतजीवासु कार्यास्तत्प्रमिताः पुनः ॥ ११० ॥

सा च द्युवृत्तक्षितिजपरमान्तरसंगुणाः ।
त्रिज्याभक्ता भवेच्छङ्कुः क्षितिज्याद्या ग्रहोन्नतिः ॥ १११ ॥

लम्बद्युवृत्तव्यासार्धकृता द्वेधा तदुन्नतिः ।
अत एव तयोर्घातो गुणस्त्रिज्याकृतिर्हृतः ॥ ११२ ॥

त्रिज्याकृतिर्लम्बभक्तो हारो द्युज्याथवा गुणः ।
द्युवृत्तोन्नतजीवायाः क्षितिजाच्छङ्कुसिद्धये ॥ ११३ ॥

द्रष्टृमध्यं ग्रहस्पृष्टं यद्वृत्तं परिकल्प्यते ।
तत्र ग्रहक्षितिजयोरन्तरं शङ्कुरिष्यते ।
तत्कोटिश्च महाच्छाया नभोमध्यग्रहान्तरम् ॥ ११४ ॥

इति ।

व्याख्या—1. A. धिकोनस्थगोलयोः.

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[1]छायायास्त्यक्त्व[2]नागाप्तं[3] लिप्ताव्यासार्धतस्त्यजेत् ॥ १९ ॥
शिष्टेन शङ्कुमाहत्य त्रिज्याप्तं त्यज्यतामिह[4] ।
छायाया,[5] श्छाययाऽऽहत्य त्रिज्याप्तं शेषतोऽपि च ॥ २० ॥

[शङ्कु-च्छायातः लम्बाक्षानयनवासना]

छायाया इति (19b-23a)—

स्वबिम्बघनमध्यान्तान्नतज्या स्यात् खमध्यतः ।
महाच्छाया तवासन्नबिम्बनेम्यवधिस्ततः ॥ ११५ ॥

बिम्बव्यासार्धधनुषस्तत्खण्डज्या तदन्तरम् ।
कृत्स्नज्याकोटिसंवर्गात् खण्डज्या त्रिज्ययोद्धृता ॥ ११६ ॥

च्छायाशङ्क्वोश्च द्वो:कोटिरूपत्वं सम्मतं मिथः ।
अतोऽत्र बिम्बव्यासार्धाच्छाया शङ्कुहतात् पृथक् ॥ ११७ ॥

शङ्कुतच्छाययोः स्वर्णं त्रिज्ययाप्तं फलद्वयम् ।
एवं दृग्विषये शङ्कुच्छाययोरिष्यते विधिः ॥ ११८ ॥

किन्त्व स्वपार्श्वलग्नेऽर्के शङ्कोर्भूपृष्ठवर्तिनः ।
छाया पूर्येत न पुनर्घनभूमध्यपार्श्वगे ॥ ११९ ॥

पार्श्वान्तरं तद्व्यासार्धं भूपृष्ठघनमध्ययोः ।
ग्रहाणां निजकक्ष्यायां कार्यास्तद्योजनैः कलाः ॥ १२० ॥

वेद्यं भगोलदृग्गोलच्छाययोरन्तरं च तत्[1] ।
त्रिज्यातुल्या यदा च्छाया दृग्गोले भास्वतो भवेत् ॥१२१॥

भूव्यासार्धकलाहीना भगोले सा निरूप्यते ।
भूव्यासार्धविहीनोऽसौ शङ्कुर्भूपृष्ठगोऽन्यतः ॥ १२२ ॥

मूलम्—. A. B. C_9 insert lines 21b and 22a before this.

2. C. त्यग 3. A. नागाप्ता

4. A. B. योजयेदिह 5. A. छायायां

व्याख्या—1. A. यत् for तत्

त्यिपेच्छङ्कौ[1] सुसूक्ष्मोऽयं शङ्कुश्च महती प्रभा ।
छायां द्वादशभिर्हत्वा शङ्कुभक्तेष्टशङ्कुभा[2] ॥ २१ ॥

[महाशङ्कोः गतगन्तव्यप्राणाः]

शङ्कुच्छाये त्रिजीवाघ्ने महत्यौ कर्णसंहृते ।
लम्बकाक्षज्ययोः [3]स्वर्णमन्योन्योत्थफलं[4] यथा ॥ २२ ॥

तथा नृच्छाययोः कार्यं विपरीतप्रभाविधौ ।
व्यासार्धघ्नात् ततः शङ्कोर्लम्बकाप्तं त्रिजीवया[5] ॥२३॥

छाया च वर्धते त्रिज्याकर्णे कोटिभुजात्वतः ।
स्वकक्ष्यागतभूव्यासार्धाहृता त्रिज्ययोद्धृता ॥ १२३ ॥

कलार्थं[1] त्रिज्ययाभ्यस्ता योजनश्रवणोद्धृता ।
भगोलगामिनी च्छाया दृग्गोले तत्फलान्विता ॥ १२४ ॥

गुणनं हरणं चात्र विहाय त्रिज्ययैकया ।
फलाभेदेन कृतयोर्द्वयोः कृतयोरपि ॥ १२५ ॥

स्फुटयोजनकर्णे स्वे भूव्यासार्धहृते ततः ।
863
व्यङ्गनागसमं[2] लब्धं येन च्छाया विभज्यते ॥ १२६ ॥

लब्धयुक्ता भगोलस्था च्छाया दृग्गोलगा भवेत् ।
तद्विहीना च दृग्गोलगामिनी स्याद् भगोलगा ॥ १२७ ॥

सा बिम्बघनमध्यान्ता बिम्बव्यासार्धसंयुता ।
तत्कोटिरेव शङ्कुः स्यादिति प्रागेव दर्शितम् ॥ १२८ ॥

मूलम्—1. A. B. शङ्कोस्त्यजेत् 2. A. C_1. शङ्कुभां
3. A. B. कार्यं for स्वर्णं 4. A. न्योत्थं फलं
5. B. लम्बकाप्तत्रिजीवया

व्याख्या—1. The mss. read कलार्थं 2. B. फलं for समं

हृत्वा द्युज्याविभक्ते तच्चरज्या स्वर्णमेव च ।
याम्योदग्गोलयोस्तस्य चापे व्यस्तं चरासवः ॥ २४ ॥
संस्कार्या गतगम्यास्ते पूर्वापरकपालयोः ॥ २५a ॥

[मध्यन्दिनच्छाया]

क्रान्त्यक्षचापयोगाच्च भेदाद्वा याम्यसौम्ययोः ॥ २५b ॥

इतरेतरतो लब्धफलसंस्कारतः स्फुटौ ।
लम्बाक्षौ कथितौ यस्मात्तुल्यन्यायकतोभयोः[1] ॥ १२९ ॥

इति ।

[महाशङ्कोः गतगन्तव्यप्राणानयनवासना]

व्यासार्धघ्नादिति (23b-25a)—

वृत्तव्यासार्धनिहता वृत्तयोरिष्टतोऽन्तरात् ।
अन्त्यान्तरालविहृता तद्दोर्ज्येष्टा भवेत् स्फुटा ॥ १३० ॥

तत्र शङ्कुर्भवेविष्टवृत्तक्षितिजान्तरम् ।
अन्तरालं परं लम्बस्ववृत्तप्रमितस्तयोः ॥ १३१ ॥

स्ववृत्तप्रमितत्वोनत्रिज्यांशत्वं विवक्षितम् ।
अतोऽत्र शङ्कुस्त्रिज्याघ्नो लम्बकेन विभज्यते ॥ १३२ ॥

वृत्तान्तरप्रतीत्यर्थं त्रिज्याघ्नं द्युज्यया हरेत् ।
उन्मण्डलावधित्वाय चरज्या क्रियते पुनः ॥ १३३ ॥

याम्योदग्गोलयोः स्वर्णं चापीकृत्य ततोऽपि च ।
कार्याश्चरासवो व्यस्तं गतैष्यप्राणसिद्धये ।
गतास्ते क्षितिजासन्नाः प्राक्कपालेऽन्यतोऽपरे ॥ १३४ ॥

इति ।

[क्रान्त्यक्षाभ्यां मध्यन्दिनच्छायानयनवासना]

क्रान्त्यक्षेति (25b-30)—

समपूर्वापरं वृत्तं साक्षेषु सममण्डलम् ।
उपर्यधश्च स्वाक्षेण[2] घटिकामण्डलं यतः ॥ १३५ ॥

व्याख्या—1. A. न्यायतयोभयोः 2. A. साक्षेण

जीवा मध्यन्दिनच्छाया, ततो वार्कस्फुटं नयेत् ॥ २६a ॥

[मध्यन्दिनच्छायया अर्कस्फुटः]

मध्यार्कनतभागेभ्यः स्वाक्षभागान् विशोधयेत् ॥ २६b ॥

शङ्कोरुदग्गता भा चेद् याम्यक्रान्तिर्हि शिष्यते ।
स्वाक्षभागान्नताश्चोना नतास्तर्हि विशोधयेत् ॥ २७ ॥

उदक्क्रान्तिस्तदा शिष्टा[1] नत्यक्षयुतिरन्यदा ।
तज्ज्या त्रिज्याहता भक्ता क्रान्त्या परमया रवेः ॥ २८ ॥

वलितं वायुगोलस्थं स्यान्निरक्षसमोपरि ।
भवेत् क्षितिजसंस्पर्शे सम्पातद्वितयं ययोः ॥ १३६ ॥

घटिकावृत्तमार्गेण प्रवहस्य परिभ्रमात् ।
ग्रहाणां क्रान्त्यभावेऽपि समपूर्वोदये सति ॥ १३७ ॥

दक्षिणोत्तरसंस्पर्शः स्वाक्षेण[1] वलते सदा ।
किं पुनः क्रान्तिसद्भावात् स तद्योगवियोगतः ॥ १३८ ॥

घटिकामण्डलस्यात्र स्वाक्षेण सममण्डलात् ।
तत्पार्श्वयोर्द्युवृत्तानां क्रान्त्यापि वलनं भवेत् ॥ १३९ ॥

तदेवार्कनतांशज्या दक्षिणोत्तरमण्डले ।
तयोर्मध्यन्दिनच्छाया तत्तुल्या व्यस्तदिग्गता ॥ १४० ॥

क्रान्त्यक्षयोः समविशोर्वर्धते क्षीयतेऽन्यतः ।
दक्षिणोत्तरवृत्ते सा गतिर्योगान्तराद्ययोः ॥ १४१ ॥

सदा याम्यदिशोऽक्षस्य याम्यक्रान्त्या यदा युतिः ।
याम्यक्रान्तिस्तदा शिष्टा नतेरक्षे विशोधिते ॥ १४२ ॥

यत्र क्रान्त्यक्षसंयोगादतिरिक्ताक्षतो नतिः ।
अत एवात्र मध्याह्नच्छाया स्यात् सौम्यदिङ्मुखी ॥ १४३ ॥

मूलम्—1. A. शिष्टं

व्याख्या—. A. साक्षेण

दोर्ज्या, तच्चापमेव स्यात् सौम्ये गोलेऽयनेऽपि च ।
रवि,स्तत्रायने भिन्ने राशिषट्कं तदूनितम् ।। २६ ।।

उदक्क्रान्त्योर्दितः सौम्ये तद्द्युवृत्तेन भास्करः ।
मध्याह्ने चलते नत्या दक्षिणे सममण्डलात् ।। १४४ ।।

नतिर्याम्या तदा मध्यच्छाया चोदङ्मुखी भवेत् ।
तत्राक्षतो नतिं त्यक्त्वा सौम्यक्रान्तिर्हि शिष्यते ।। १४५ ।।

सौम्यादपक्रमादक्षस्याधिक्यं यत्र लक्ष्यते ।
अधोदक्क्रान्तिरधिका यदाक्षादुपलभ्यते ।। १४६ ।।

तदा तद्वलयं याम्यं लङ्घयेदुत्तरा नतिः ।
यत्र मध्यन्दिनच्छाया दृश्यते याम्यदिङ्मुखी ।। १४७ ।।

नत्यक्षधनुषोर्योगस्तदोदक्क्रान्तिरिष्यते ।
क्रान्तिज्येष्टान्तरं चोक्तं घटिकाक्रान्तिवृत्तयोः ।। १४८ ।।

इष्टान्तराहृता त्रिज्या तयोरन्त्यान्तरोद्धृता ।
क्रान्तिवृत्तगता दोर्ज्या स्यादासन्नविषुवावधिः ।। १४९ ।।

तच्चापं सायनार्कः स्यात् तत्काले प्रथमे पदे ।
यदा स्यात् सौम्यदिक्कत्वं द्वयोरयनगोलयोः ।। १५० ।।

तच्चापहीनं चक्रार्धं तत्र याम्येऽयने सति ।
चक्रार्धयुक्तं तद्याम्यदिशोरयनगोलयोः ।। १५१ ।।

[1]मण्डलं तद्विहीनं च तत्र सौम्येऽयने सति ।
ओजयोः पदयोर्यस्मादधस्ताद्विषुवद्द्वयम् ।। १५२ ।।

प्रत्यासन्नं गतज्यैव ततोऽत्र विषुवावधिः ।
अधस्तश्चापमेवात्र कल्प्यते सायनो रविः ।। १५३ ।।

आद्ये पदे तृतीये तु पदे षड्राशिसंयुतः ।
युग्मयोः पदयोस्तूर्ध्वमासन्नं विषुवद्द्वयम् ।। १५४ ।।

व्याख्या—1. C. For the verse मण्डलं etc., C. reads only तच्चापहीनं योर्यस्मात् दधस्ताद्विषुवद् द्वयम् (?) ।

याम्ये[1] गोलेऽयने चापि राशिषट्कयुतं रविः ।
तदूनं मण्डलं भानुर्याम्यस्थे चोत्तरायणे ॥ ३० ॥

[अयनचलनम्]

करणागतसूर्यस्य छायानीतस्य चान्तरम् ।
आयनं चलनं ज्ञेयं तात्कालिकमिदं स्फुटम् ॥ ३१ ॥

गन्तव्यज्याधनुस्तत्र कल्प्यते सायनो रविः ।
पदे द्वितीये चक्रार्धस्य[ाज्य][1]स्तुर्ये तु चक्रतः ।
उदग्विषुववादिः स्यादजादिः सायनो रविः ॥ १५५ ॥

इति ।

[तात्कालिकायनचलनवासना]

करणागतेति (31-35a)—

यदुक्तं दक्षिणे गोले नतिः क्रान्त्यक्षयोर्युतिः ।
तत्रैकरूपेणाक्षेण स्वदेशे श्रूयते सदा ॥ १५६ ॥

प्रदेशभेदाद् भूपृष्ठे तस्य भेदसमर्थनात् ।
विषुवद्दिनमध्याह्नच्छायायत्तो यतो[2] हि सः ॥ १५७ ॥

नतत्वाद् वायुगोलस्य स्वदेशसममण्डलात् ।
सदा दृश्यार्धमध्यस्य दक्षिणेन खमध्यतः ॥ १५८ ॥

विषुवद्दिनमध्याह्नच्छाया भिद्येत सर्वतः ।
तथाप्यभिन्नदेशस्था सैकरूपोपलभ्यते ॥ १५९ ॥

अतस्तद्वशतोऽक्षस्याप्येकरूपत्वसम्भवात् ।
इष्टक्रान्त्यैव भिद्येत दिनमध्ये रवेर्नतिः ॥ १६० ॥

सैव मध्यन्दिनच्छाया किन्त्वेषा व्यस्तदिग्गता ।
पूर्णायां क्रान्तिजीवायां तत्रासौ पूर्णतामियात् ॥ १६१ ॥

मूलम्—1. C. सौम्ये for याम्ये

व्याख्या—1. A, B. om. the bracketted portion. C. om. the entire verse पदे द्वितीये etc.

2. B. मतो for यतो

छायार्कादधिकेऽन्यस्मिन् शोध्यं, योज्यं विपर्यये ।
उदग्विषुवद्दादित्वसिद्धये करणागते ॥ ३२ ॥

क्रमात् तत्पार्श्वमध्याह्नच्छाययोरल्पतावशात् ।
याम्यगोले यथा पूर्णा मध्यच्छायोपलभ्यते ॥ १६२ ॥

याम्यायनान्तरतत्रैव परमक्रान्तिलक्षणः ।
अन्तरं यादृशं तस्य दृश्यते करणागतात् ॥ १६३ ॥

चलितत्वाद् भगोलस्य कृत्स्नस्यापीह तावता ।
आयनं चलनं तादृक् तदानीमवगम्यते ॥ १६४ ॥

अयनं नाम घटिकाक्रान्तिवृत्तान्तरं परम् ।
यस्मिन् प्रदेशे घटिकाक्रान्तिमण्डलयोर्यदा ॥ १६५ ॥

[1]विप्रकर्षः परो दृष्टः स तु कालान्तरे ततः ।
पुरस्ताच्च परस्ताच्च चलति प्राक्प्रदेशतः ॥ १६६ ॥

चापान्ते मिथुनान्ते च विप्रकर्षः परोऽत्र यः ।
स चिरेण तयोः सप्तविंशत्यंशान्तरे ततः ॥ १६७ ॥

प्रदेशान्तरसम्बन्धो न युक्तश्चलनं विना ।
अतोऽयनस्य चलनं वृत्तयोरनुमीयते ॥ १६८ ॥

चलति स्वद्युवृत्तेन भकूटद्वितयं तथा ।
अंशकैः सप्तविंशत्या स्ववृत्तप्रमितैस्ततः ॥ १६९ ॥

चलतः क्रान्तिवृत्तस्य घटिकावृत्तसंयुतिः ।
दृष्टैवाचलिते तस्मिन् सा प्रदेशान्तरस्थिता ॥ १७० ॥

भकूटेन विना क्रान्तिवृत्तमेव चलेद्यदि ।
भगोलमध्यावस्थत्वं क्रान्तिवृत्तस्य हीयते ॥ १७१ ॥

प्रसिद्धो हीयते लग्नव्यवहाराविरव्यतः ।
अतो भकूटयोर्वेद्यं चलनं स्वद्युमण्डले ॥ १७२ ॥

व्याख्या—1. A. Hap. repetition of the three lines विप्रकर्षः, पुरस्ताच्च and चापान्ते ।

मेषादिके ग्रहे कार्यमंशादिकमिदं खलु ।
वृद्धिः क्षयश्च दिव्याब्दैः पञ्चभिः स्याद् धनर्णयोः ॥ ३३ ॥

घटिकामण्डलस्यापि चलनं न कदाचन ।
व्यवस्थितत्वात् तस्यैतत्पार्श्वस्थध्रुवयोरपि ॥ १७३ ॥

घटिकामण्डलं वायुगोले भ्रमति तद्वशम् ।
विषुवत्स्वस्तिकात् क्रान्तिघटिकावृत्तयोगतः ॥ १७४ ॥

दिग्व्यवस्था प्रसिद्धेयं नान्यथा स्यात् कदाचन ।
घटिकामण्डलस्यातश्चलनं नोपपद्यते ॥ १७५ ॥

भकूटस्यैव चलनं विषुश्चलन[1]मायनम् ।
क्रान्तिवृत्तं यदि चलेद् भानि तत्र स्थितान्यतः ॥ १७६ ॥

भ्रमन्ति भिन्नकालानि तद्वशात् तद्दिनानि च ।
भकूटस्यैव चलनं ततश्चलनमायनम् ॥ १७७ ॥

ततः क्रान्तेर्घटीवृत्ताद् विप्रकर्षोऽप्यनुक्षणम् ।
तथा हि घटिकाक्रान्तिवृत्तयोरेककेन्द्रयोः ॥ १७८ ॥

परमापक्रमः प्रोक्तस्तुल्ययोः परमान्तरम् ।
यदक्षयोगभेदाभ्यां दिनमध्ये रवेर्नतिः ॥ १७९ ॥

मध्यच्छायाथवा व्यस्तं दक्षिणोत्तरगोलयोः ।
छायायां तत्र पूर्णायां क्रान्तेः पूर्णत्वसम्भवात् ॥ १८० ॥

पार्श्वयो[2]रुभयोस्तस्याः क्रमेणाल्पत्वदर्शनात् ।
भाव्यं तत्रायनान्तेन दृक्संवादान्निरर्गलम् ॥ १८१ ॥

सौम्ययाम्यायनान्तौ द्वौ चक्रार्धान्तरितौ मिथः ।
तयोर्मध्ये च गोलान्तौ तावतान्तरितौ मिथः ॥ १८२ ॥

सम्पातसम्भवात् तत्र घटिकाक्रान्तिवृत्तयोः ।
इष्टान्तरालभूतासौ क्रान्तिज्या नोपलभ्यते ॥ १८३ ॥

व्याख्या—1. A. विदुर्वलन; B. विदु-लन 2. C. क्रान्तयो

दशांशोनाब्दतुल्या स्याद् गतिस्तस्य कलात्मिका।
सप्तविंशतिभागान्तं चलनं चापनक्रयोः ॥ ३४ ॥
सिद्धान्तेषूदितं, तस्य छाययापि विनिर्णयः ॥ ३५a ॥

घटिकामण्डलाभिन्नं ततस्तत्र द्युमण्डलम् ।
दृश्यादृश्यार्धयोर्यस्य क्षितिजेन विभिन्नयोः ॥ १८४ ॥

तुल्यत्वात् तद्भ्रमोद्भूतद्युनिशोरपि तुल्यता ।
अत एव च[1] सम्पातो विषुवत्वेन सम्मतः ॥ १८५ ॥

गोलायनान्तद्वययोर्भेदश्चेत् करणागतात् ।
न भगोलस्य[2] कृत्स्नस्य भेदे सत्येव युज्यते ॥ १८६ ॥

[3]गोलायनान्तद्वययोर्भगोलावयवं ततः[4] ।
चलत्यवयवा नैव चलत्यवयवी स्वयम्[5] ॥ १८७ ॥

इति तत्त्वविदां पक्षो नातीव हृदयङ्गमः ।
तत्र कृत्स्नो भगोलोऽयं यदैव प्राङ्मुखश्चलेत् ॥ १८८ ॥

पश्चाद्गतत्वान्मेषादेस्ततस्तत्र तदन्तरम् ।
उदग्विषुवदादित्वसिद्धये प्रविशोध्यते ॥ १८९ ॥

यतो मेषादितस्तावदतीत्य विषुवत् स्थितम् ।
यदा पश्चान्मुखं तस्य चलनं प्रक्षिपेत् तदा ॥ १९० ॥

उदग्विषुवतस्तत्र तावता प्राक्प्रवृत्तितः[6] ।
वृद्धि क्षयश्च विध्याब्दैः पञ्चभिस्तद्धनर्णयोः[7] ॥ १९१ ॥

विध्याब्दपञ्चकं येन तत्पदत्वेन कल्प्यते ।
तत एवास्य विध्याब्दविंशत्यैवैकपर्ययः ॥ १९२ ॥

व्याख्या—1. B. Gap for च
2. B. समगोलस्य
3. A. adds भ before गोल
4. C. च तत् for ततः
5. C. चलत्यवनिस्वनम्
6. C, प्रवर्तितः
7. C. पञ्चभिः स्याद्धनर्णयोः

[नत्यपक्रमाभ्याम् अक्षः]

क्रान्त्यर्कनतिभेदोऽक्षो याम्ये गोले युतिः पुनः ॥ ३५b ॥
छायायामपि सौम्येऽर्केऽप्यन्यथा स्यात्तदन्तरम् ॥ ३६a ॥

तैर्द्वाविंशसहस्रैस्तु मिते तस्माच्चतुर्युगे ।
विंशांशाः पर्ययास्तस्य कथिताः षट्छतीमिताः ॥ १९३ ॥

दिव्याब्दो मानुषाब्दानां षष्ट्युत्तरशतत्रयम् ।
दशांशोनाब्दतुल्या सा भगोलस्य कलागतिः[1] ॥ १९४ ॥

आद्यत्र्यंशेऽब्दतुल्या सा दशांशोना च मध्यमे ।
पञ्चमांशविहीनान्त्ये तत्र सा परिकल्प्यते ॥ १९५ ॥

दशांशोनाब्दतुल्यत्वं सम्भूयोक्तं गतेस्ततः ।
चापज्याखण्ड यत्प्रायस्तद्वृद्धिक्षयसम्भवात् ॥ १९६ ॥

[नत्यपक्रमाभ्यां अक्षानयनवासना]

क्रान्त्यक्षेति (35b-36b)—

ग्रहाणां घटिकाक्रान्तिवृत्तसम्पातगामिनाम् ।
समपूर्वापितानामप्यक्षेण वलते सदा ॥ १९७ ॥

दक्षिणोत्तरसंस्पर्शो दक्षिणेन खमध्यतः ।
स तु क्रान्त्यक्षसंयोगाद् दक्षिणक्रान्तिसम्भवे ॥ १९८ ॥

सत्यां पुनरुदक्क्रान्तौ तस्यैतस्य द्वयी गतिः ।
अक्षस्याधिक्यतः क्रान्तेर्याम्ये सौम्ये विपर्ययात् ॥ १९९ ॥

दक्षिणोत्तरवृत्ते तत् खमध्याद् वलनं रवेः ।
क्रान्त्यक्षभेदयोगाभ्यां तदेव वलनं नतिः ॥ २०० ॥

नतिः क्रान्त्यक्षयोगाच्चेन्नतेः क्रान्तिविशोधनात् ।
क्रान्त्यक्षयोस्तु विश्लेषे क्रान्तेर्नतिविशोधनात् ॥ २०१ ॥

अक्षात् क्रान्तेर्विशुद्धत्वे नतिक्रान्त्योर्युतेरपि ।
अक्षज्या भवतीत्येतदुपपन्नं भवेत् ततः ॥ २०२ ॥

व्याख्या—1. A. तथा गतिः

[छायया दिग्वगमनम्]

सायनार्कभुजाजीवा परमक्रान्तिताडिता ॥ ३६^{b} ॥

लम्बकाप्ताग्रजीवा स्याच्छायाकर्णहता हृता ।
त्रिज्ययाग्राङ्गुलं याम्ये विषुवच्छायुतं भुजा ॥ ३७ ॥

सौम्याथ सौम्यगोलेऽपि न्यूनमग्राङ्गुलं यदि ।
शोधयेद् विषुवच्छायाः सौम्यो बाहुस्तदापि च ॥ ३८ ॥

सायनार्केति (36b-50) —

[छायया दिङ्निर्णयवासना]

भगोलं भ्रामयेत् प्रत्यक् सग्रहं प्रवहोऽन्वहम् ।
खन्मार्गमध्यतो याति निरक्षसमपश्चिमम् ॥ २०३ ॥

घटिकामण्डलं पार्श्वगतानन्तद्युमण्डलम् ।
निरक्षदेशतस्तत्र साक्षाणां सौम्यतः स्थितेः ॥ २०४ ॥

समोपरिगतं वृत्तं साक्षेण वलते ततः ।
समोपरिगतं वृत्तं साक्षेषु सममण्डलम् ॥ २०५ ॥

समोपरि निरक्षेषु घटिकामण्डलं तथा ।
दक्षिणोत्तरसंस्पर्शः स्वाक्षेणान्तरितस्तयोः ॥ २०६ ॥

न तु क्षितिजसंस्पर्शस्तत्र सम्पाततस्तयोः ।
[1]ततस्तदन्तरालेषु वलनं कल्प्यतेऽक्षतः ॥ २०७ ॥

समपूर्वापरे तत्र कल्पिते सममण्डले ।
घटिकामण्डलस्यैव ततो वलनकल्पना ॥ २०८ ॥

भक्षेण तुल्यं व्यासार्धे क्षितिजादुन्नते च तत् ।
उन्नते घटिकावृत्ते लम्बेनाक्षसमं हि तत् ॥ २०९ ॥

व्याख्या—1. C. तत्र for ततः

विषुवच्छ्रां त्यजेत् तस्माद् रवावुत्तरगेऽधिकात् ।
याम्य एव तदा बाहुस्तच्छायाकृतिभेदतः ॥ ३९ ॥

मूलं कोटिः, श्रुतिः, छाया त्रिभिस्त्र्यश्रं भवेदिदम् ।
भ्रामयित्वाऽथ तत् त्र्यश्रं यावच्छायानुगा श्रुतिः ॥ ४० ॥

कोट्या पूर्वापरे ज्ञेये, बाहुना दक्षिणोत्तरे ॥ ४१[a] ॥

ताभ्यां त्रैराशिकात् साध्यमिष्टशङ्कून्नतेश्च तत् ।
योगविश्लेषयोग्यं च भवेदर्काग्रयापि तत् ॥ २१० ॥

अर्काग्रा घटिकेष्टद्युवृत्तयोः क्षितिजेऽन्तरम् ।
क्रान्तिज्योन्मण्डले कर्णकोटयौ ते, क्षितिजा भुजा ॥ २११ ॥

त्रिज्यालम्बकयोरक्षः कर्णकोटयौ भुजा यथा ।
तुल्यस्वभावता यस्माद् द्वयोस्त्रिभुजयोस्तयोः ॥ २१२ ॥

साध्याः स्युः कोटिदोःकर्णा मिथस्त्रैराशिकात् ततः ।
अत एवार्कदोःक्रान्तिस्त्रिज्याघ्ना लम्बकोद्धृता ॥ २१३ ॥

दोर्ज्या वापक्रमक्रान्तिनिहता लम्बकोद्धृता ।
हरणं गुणनं चान्तर्विहाय त्रिज्ययैकया ॥ २१४ ॥

अर्काग्रा स्याद् यदन्तेऽर्कः सममण्डलतो भवेत् ।
तद्दिशि क्षितिजस्पर्शो याम्योदग्गोलयो रवेः ॥ ११५ ॥

क्षितिजादुन्नमन्नर्कः प्रवहप्रेरणात् क्रमात् ।
याम्यदिश्येव मध्याह्नं यात्यस्तोदयसूत्रतः ॥ २१६ ॥

वलनाद् वायुगोलस्य स्वाक्षेण सममण्डलात् ।
घटिकामण्डलं यत्र सममण्डलतां व्रजेत् ॥ २१७ ॥

अर्काग्रा क्रान्तितुल्या स्यात् तत्राक्षोन्नत्यभावतः ।
याम्यतोऽक्षेण वलने सत्यर्काग्रा ततोऽधिका ॥ २१८ ॥

छायाभुजा तु शङ्क्वग्रं याम्यार्काग्रासमन्वितम् ।
उदङ्मुखी च शङ्क्वग्रान्न्यूनार्काग्रा यदोत्तरा ॥ २१९ ॥

शङ्क्वग्रतो विशोध्यैनां शिष्टा छायाभुजोत्तरा ।
शङ्क्वग्ररहितार्काग्रा त्वन्यथा याम्यदिङ्मुखी ॥ २२० ॥

अक्षजीवाहताच्छङ्कोः शङ्क्वग्रं लम्बकोद्धृतम् ।
यदग्रे क्षितिजे शङ्कुः स्यादस्तोदयसूत्रतः ॥ २२१ ॥

योगभेदा[वेव कार्यौ][1] शङ्क्वग्रार्काग्रयोस्ततः ।
द्वयोरन्योन्यशेषत्वादेकवृत्तगतत्वतः ॥ २२२ ॥

यद्यप्यन्योन्यकोटिघ्नत्रिज्याभक्तावुभौ गुणौ ।
योगभेदक्षमौ स्यातां तथाप्यत्राग्रयोर्द्वयोः ॥ २२३ ॥

मार्गभेदाद्योगभेदौ कार्यौ केवलयोरिह ।
अन्यत्र विषुवन्मूलादर्काग्रा दक्षिणोत्तरा ॥ २२४ ॥

तदग्रादपि शङ्क्वग्रं प्रवृत्तं[2] नित्यदक्षिणम् ।
सत्यं प्रवर्ततेऽर्काग्रा विषुवत्क्षितिजाश्रिता ॥ २२५ ॥

इष्टद्युवृत्तं यद् यच्च तत्तुल्यं सममण्डलम् ।
तयोरिष्टान्तरालं तु शङ्क्वग्रं कथितं बुधैः ॥ २२६ ॥

दक्षिणोत्तरवृत्ते स्यात् तयोः परममन्तरम् ।
परान्तरानुसारेण स्थितेरिष्टान्तरस्य च ॥ २२७ ॥

दक्षिणोत्तरता नित्यमाशाग्रावध्यवस्थिता ।
शङ्कोरग्रगतं तत्तु तन्मूलेऽपि च कल्प्यते ॥ २२८ ॥
अतः क्षितिजगामित्वं[3] तस्यार्काग्रावदास्थितम्[4] ।
एकमार्गप्रसृतयोर्दक्षिणोत्तरयोस्तयोः ॥ २२९ ॥

तिर्यक्त्वाभावतोऽन्योन्यकोटघा न हतिरिष्यते ।
अतः केवलयोरेव कार्ये योगान्तरे तयोः ॥ २३० ॥

शङ्क्वग्रार्काग्रयोस्तस्माद् दक्षिणोत्तरगोलयोः ।
योगान्तरकृता छायाभुजा स्याद् व्यस्तदिङ्मुखी ॥ २३१ ॥

व्याख्या—1. Mss. defective and show a gap.
2. A. C. प्रवृत्ति   3. C. गामित्वां
4. C. तस्यार्काग्रवदवस्थितम्

[छायाभ्रमणवृत्तपरिलेखः]

छायाभ्रमणमप्येवं ज्ञेयमिष्टदिनोद्भवम् ॥ ४१b ॥

इष्टकालोद्भवां छायां बाहुं कोटिं[1] च पूर्ववत् ।
तत्तुल्याभिः शलाकाभिस्तिसृभिस्त्रिभुजं तथा ॥ ४२ ॥

कृत्वा, पूर्वापरां कोटिं वृत्तमध्याद् यथादिशम् ।
कृत्वा, बाहुं च बाहोश्च छायायाश्चाग्रयोर्युतौ ॥ ४३ ॥

बिन्दुं कृत्वाऽपराह्णेऽपि बिन्दुं तत्र प्रकल्पयेत् ।
मध्यच्छायाशिरस्यन्यस्तृतीयो बिन्दुरिष्यते ॥ ४४ ॥

लिखेद् वृत्तत्रयं, तेन[2] यथा मत्स्यद्वयं भवेत् ।
तन्मत्स्यमध्यगे सूत्रे प्रसार्यैव तयोर्युतिः ॥ ४५ ॥

दृश्यते यत्र तन्मध्यं वृत्तं[3] बिन्दुस्पृगालिखेत् ।
छाया तन्नेमिगा तस्मिन् दिने स्यात् सर्वदापि च ॥ ४६ ॥

छायातद्भुजयोः कोटिर्वर्गान्तरपदं भवेत् ।
छायाभुजानुसारित्वं दक्षिणोत्तरयोर्दिशोः ॥ २३२ ॥

छायाकोट्यनुसारित्वं पूर्वापरदिशोरपि ।
तत्तुल्याभिः शलाकाभिः तदर्थं त्रिभुजे कृते ॥ २३३ ॥

तत्र शङ्कुं निधायेष्टकर्णकोट्यग्रसंयुतौ ।
यदा कर्णशलाकास्था च्छाया तत्प्रमिता भवेत् ॥ २३४ ॥

भुजाकोटिशलाके द्वे दिक्परिच्छेदिके तदा[1] ।
छायाकोट्यनुसारेण तत्र पूर्वापरे दिशौ ॥ २३५ ॥

मूलम् — 1. A. B. बाहुकोटिं 2. A. C_{10} तेषु for तेन
3. B. om. वृत्तं

व्याख्या—1. A. परिच्छेदकैस्तथा ; C. परिच्छेदके तथा

[प्रकारान्तरेण छायाभुजानयनम्]

अक्षज्याघ्नान्महाशङ्कोः शङ्क्वग्रं लम्बकाहृतम् ।
सर्वदा दक्षिणं तद्धि, योज्यमर्काग्रयापि तत् ॥ ४७ ॥

याम्ये गोले महाबाहुः, सौम्ये चाग्रद्वयान्तरम् ।
अधिकेऽत्रापि शङ्क्वग्रे याम्यः स्यादन्यथोत्तरः ॥ ४८ ॥

छायाकर्णहतः, सोऽपि त्रिज्याभक्तोऽङ्गुलात्मकः ।
विपरीतदिगप्येष पूर्वानीतसमोऽपि च ॥ ४९ ॥

द्वादशघ्नोऽथवा बाहुः शङ्कुना महता हृतः ।
अङ्गुलात्मकमेवं वा छायाभ्यामथवा नयेत् ॥ ५० ॥

छायाभुजानुसारेण याम्योत्तरदिशावपि ।
एवमिष्टदिने कार्यं छायया दिग्विनिर्णयः ॥ २३६ ॥

[छायावृत्तपरिलेखन प्रकारः]

अथ यस्मिन् दिने च्छायाभ्रमवृत्तं चिकीर्षितम् ।
तत्र च्छायाभुजाकोटित्रयं स्फुटतरं नयेत् ॥ २३७ ॥

तत्तुल्याभिः शलाकाभिः त्रिभुजद्वितये कृते ।
तत्र कोटिशलाके द्वे पूर्वापरदिगाश्रिते ॥ २३८ ॥

कर्णकोट्यग्रसम्पाते शङ्कुमूलं द्वयोरपि ।
यस्य शङ्कोरिमाश्छायास्तद्भुजाकोटयो मताः ॥ २३९ ॥

छायाभुजाग्रयोर्बिन्दू कुर्यात् पूर्वापराह्णयोः ।
तृतीयमपरं बिन्दुं मध्यच्छायाग्रगामिनम् ॥ २४० ॥

तद्बिन्दुत्रितयस्पृष्टे वृत्ते सम्यक् प्रकल्पिते ।
छायाग्रं वृत्तपरिधौ तत्र भ्राम्यति तद्दिने ॥ २४१ ॥

भाग्रं तुल्यान्तरालाभ्यां बिन्दुभ्यां निजमध्यतः ।
ततः समतिरश्चीनान्मार्गावपि च सर्वतः ॥ २४२ ॥

[सम(मण्डल)शङ्कुः]

अक्षज्योना यदा क्रान्तिः सौम्या, तां त्रिज्यया हताम् ।
अक्षज्यया विभज्याप्तः शङ्कुः स्यात् सममण्डले ॥ ५१ ॥

[समशङ्कुना अर्कस्फुटः]

अक्षज्याघ्नः परक्रान्त्या[1] हृतः शङ्कुः स दोर्गुणः[2] ।
तच्चापमेव भानुः स्यात् चक्रार्धं वा तदूनितम् ॥ ५२ ॥

तयोरेकतरस्यातस्तृतीयस्यापि मध्यतः ।
भाव्यं तुल्यान्तरालाभ्यां ताभ्यां तन्मध्यमार्गतः ॥ २४३ ॥

सम्पातो मार्गयोर्यत्र ततो दूरप्रसारणात् ।
ततस्त्रिभिश्च तैस्तुल्यैर्भवितव्यं यतस्ततः ॥ २४४ ॥

सम्पाततस्तदेकस्पृग्वृत्तं सर्वाण्यपि स्पृशेत् ।
स्वमध्यमार्गसम्पातात् त्रिस्पृग्वृत्तं ततः स्मृतम् ॥ २४५ ॥

छायाभ्रमणवृत्तं यदुक्तं प्रायिकमेव तत् ।
वृत्तमार्गेण भाग्रस्य भ्रमणानुपपत्तितः ।
पूर्वाचार्यानुरोधेन केवलं तद्विहोदितम् ॥ २४६ ॥

[समशङ्कुः तद्द्वारा स्फुटार्कश्च]

अक्षज्योनेति (51-52)—

उदगर्काग्रया तुल्ये शङ्क्वग्रे नित्यदक्षिणे ।
प्रतिक्षणं भिन्नरूपे यात्यर्कः सममण्डलम् ॥ २४७ ॥

[तदर्थं न्यूनता क्रान्तेः सौम्यता][1] कथ्यतेऽक्षतः ।
क्रान्त्यक्षनियमो वेद्यः शङ्क्वर्काग्राग्रयोरपि ॥ २४८ ॥

सौम्यक्रान्तेर्यदाक्षेण तुल्यता जायते क्रमात् ।
द्रष्टुः समोपरि तदा यात्यर्कः सममण्डलम् ॥ २४९ ॥

उदक्क्रान्त्यल्पतायत्ता समशङ्क्वल्पता ततः ।
क्रान्तिः सौम्याक्षतुल्या चेत् समशङ्कुस्त्रिमौर्विका ॥ २५० ॥

मूलम्— 1. C_1. पराक्रान्त्या 2. A. स्वदोर्गुणः

व्याख्या—1. Mss. read : तदर्थंन्यूनता क्रान्ते सौम्या ता।

[समशङ्कोरङ्गुलात्मकः कर्णः]

लम्बाक्षज्ये विषुवद्भार्कघ्ने क्रान्तिजीवया भक्ते ।
सममण्डलगे भानौ कर्णौ तावङ्गुलात्मकौ स्पष्टौ ॥ ५३ ॥

समोपरिष्टादर्कस्य दिनमध्ये प्रवृत्तितः ।
अक्षतो न्यूनसंख्यायास्तस्याः शङ्कुं ततो नयेत् ॥ २५१ ॥

शङ्कौ त्रिज्यासमे सौम्यक्रान्तिरक्षसमा यदि ।
समशङ्कौ ततो न्यूने तत्क्रान्तिमपि चानयेत् ॥ २५२ ॥

अन्त्यक्रान्तिसमायां च क्रान्त्यां त्रिज्या भुजा यदा ।
क्रान्त्यां ततोऽथ न्यूनायां दोर्ज्यां त्रैराशिकान्नयेत् ॥ २५३ ॥

दोर्ज्याचापसमो भानुस्तत्काले प्रथमे पदे ।
द्वितीये तु पदे वेद्यं चक्रार्धं स्यात् तदूनितम् ॥ २५४ ॥

क्रान्त्यल्पतावशात् सौम्यगोले चेत् पदयोर्द्वयोः ।
सायनार्कस्य सममण्डलप्राप्तिर्भवेद् यतः ॥ २५५ ॥

इति ।

[समशङ्कुसम्बन्धि-द्वादशाङ्गुलशङ्कु-कर्णवासना]

लम्बाक्षज्ये इति (53-55a) —

उदक्क्रान्त्यक्षसाम्ये तु समशङ्कुस्त्रिमौर्विका ।
समोपरि यदा द्रष्टुर्यात्यर्कः सममण्डलम् ॥ २५६ ॥

छायायां शङ्कुलीनायां तत्कर्णोऽपि च तत्समः ।
न्यूनायामक्षतः क्रान्त्यां शङ्कौ च द्वादशाङ्गुले ॥ २५७ ॥

तत्कर्णो वर्धते तस्माद् व्यस्तत्रैराशिकोद्गमात् ।
इच्छाल्पतावशाद् यत्र तत्फलं वर्धते क्रमात् ॥ २५८ ॥

प्रमाणफलयोर्घातात् फलं तत्रेच्छया हृतम् ।
समशङ्कुर्हतोऽक्षेण त्रिज्याघ्नोदगपक्रमात् ॥ २५९ ॥

त्रिज्या चेद् द्वादशाभ्यस्ता ह्रियेत समशङ्कुना ।
शङ्कोर्द्वादशसंख्यस्य कर्णो यः सममण्डले ॥ २६० ॥

[प्रकारान्तरेण समशङ्कुकर्णः]

मध्यच्छाया यदा मध्ये विषुवत्समरेखयोः ।
तन्मध्याह्नभवः कर्णो विषुवच्छायया हतः ॥ ५४ ॥
मध्याह्नाग्राङ्गुलैर्भक्तः कर्णः स्यात् सममण्डले ॥ ५५a ॥

[समशङ्कुना गतैष्यप्राणाः]

सममण्डलशङ्कुर्लम्बघ्नस्त्रिज्यया हृतः ॥ ५५b ॥

अक्षज्या द्वादशाभ्यस्ता तया क्रान्त्या विभज्यताम् ।
अक्षांशः समशङ्कुः स्यात् त्रिज्यापक्रमयोर्वध ात् ॥ २६१ ॥
समशङ्क्वंशकः कर्णो द्वादशत्रिज्ययोर्वधात् ।
त्रिज्यामेकान्ततस्त्यक्त्वा भाज्यभाजकगामिनीम् ॥ २६२ ॥

अक्षज्यां द्वादशाभ्यस्तामुदक्क्रान्त्या तया हरेत् ।
सममण्डलकर्णः स्यात् तत्र लब्धोऽङ्गुलात्मकः ॥ २६३ ॥

यद्वेवं विषुवद्भाघ्नं लम्बं क्रान्त्या तया हरेत् ।
सममण्डलकर्णः स्यात् साम्यतो घातयोस्तयोः ॥ २६४ ॥

अक्षज्या द्वादशाभ्यस्ता लम्बघ्ना विषुवत्प्रभा ।
तुल्ये स्यातामुभे दोःकोटचात्मकत्वान्मिथस्तयोः ॥ २६५ ॥

इतरेतरदोःकोटचोः क्षेत्रयोर्घातसाम्यतः ।
कर्णो माध्याह्निको[1] यद्वा विषुवच्छायया हतः ॥ २६६ ॥

मध्याह्नाग्राङ्गुलैर्भक्तः कर्णः स्यात् सममण्डले ।
मध्यच्छाया तदा मध्ये विषुवत्समरेखयोः ॥ २६७ ॥

विशोध्य विषुवच्छाया दिनमध्योद्भवां प्रभाम् ।
मध्याह्नाग्राङ्गुलानि स्युरवशिष्टसमानि हि ॥ २६८ ॥

व्याख्या—1. B. मध्याह्निको

उन्मण्डला द्युवृत्तज्या, त्रिज्याघ्ना द्युज्यया हृता ।
तच्चापं चरचापाढ्यं गतैष्यासव एव हि ॥ ५६ ॥

[समशङ्कुना नतप्राणाः]

लम्बघ्नः समशङ्कुः स द्युज्याभक्तोऽथ तत्कृतिम् ।
त्यक्त्वा त्रिज्याकृतेर्मूलं चापितं हि नतासवः ॥ ५७ ॥

सममण्डलग इति (55b-59)—

[अक्षक्षेत्राणि]

द्युवृत्तेष्टान्तरालं यत्क्षितिजात् सममण्डले ।
समशङ्कुरसौ कोटिर्द्युवृत्ते कर्णतां गते ॥ २६९ ॥

यद्यपि क्षितिजाद्दिष्टान्तरं कर्णो द्युवृत्तगम् ।
तथाप्युन्मण्डलादूर्ध्वखण्डस्येष्टैव कोटिका[1] ॥ २७० ॥

समशङ्कुश्च तत्कर्णः क्रान्तिज्या च भुजा भवेत् ।
उन्मण्डलक्षितिजयोर्यद् द्युवृत्तस्थमन्तरम् ॥ २७१ ॥

कर्णात् पृथक्कृते कोटिखण्डे यद्वशिष्यते ।
क्षितिज्या सा भुजार्काग्रा कर्णः कोटिरपक्रमः ॥ २७२ ॥

[समशङ्कुना गतैष्यप्राणाः नतप्राणाश्च]

एवं त्र्यश्रद्वयं त्र्यश्रे त्वेकस्मिन्नवतिष्ठते ।
त्रिज्याक्षलम्बकत्र्यश्रं[2] यत्तत् त्र्यश्रत्रयं तु तत् ॥ २७३ ॥

उन्मण्डलाद् द्युवृत्ते यत् तस्यैवेष्टान्तरं भवेत् ।
कर्णरूपे समे शङ्कौ या कोटिः परिकल्पिता ॥ २७४ ॥

लम्बकेनाहृता त्रिज्याभक्तत्वात् समशङ्कुतः ।
त्रिज्यया गुणनाद् भूयो द्युज्यया हरणादपि ॥ २७५ ॥

व्याख्या—1. B. कोटिता		2. A. B. त्र्यश्रा

[प्रकारान्तरेण नतप्राणाः]

सममण्डलगा छाया त्रिज्याघ्ना द्युज्यया हृता ।
चापिता वा नतप्राणाः कोट्या वा सर्वदा तथा ॥ ५८ ॥

[समशङ्कोः क्षितिज्या]

अक्षज्याघ्नौ समौ शङ्कू त्रिज्यालम्बकभाजितौ ।
क्रान्त्यर्काग्रे, तयोः कृत्योर्भेदमूलं क्षितेर्गुणः ॥ ५९ ॥

द्युवृत्तप्रमितं चापं यदीयं तून्नतासवः ।
उन्मण्डलात् प्रवृत्तानां तेषां क्षितिजतोऽपि च ॥ २७६ ॥

प्रवृत्तिरिष्टा स्वचरप्राणसंयोगतस्तदा ।
द्युवृत्तेष्टान्तरालज्या[1] दक्षिणोत्तरमण्डलात् ॥ २७७ ॥

द्युवृत्तप्रमितं त्रिज्यागुणितं द्युज्यया हृतम् ।
तच्चापं तन्नतप्राणाः समच्छायाकृताः सदा ॥ २७८ ॥

द्युवृत्तेष्टान्तरालज्या या तून्मण्डलतोऽथवा ।
सममण्डलसम्पातावधिका तत्र तन्मिता ॥ २७९ ॥

तत्त्रिज्याकृतिविश्लेषमूलचापं नतासवः ।
त्रिज्याघ्ना द्युज्यया भक्ता च्छायाकोटिः सदाथवा ॥ २८० ॥

तच्चापं तन्नतप्राणा दक्षिणोत्तरसङ्क्रमात् ।
अत एव नतांशज्या द्युज्याघ्ना[2] त्रिज्यया हृता ॥ २८१ ॥

समच्छाया भवेदिष्टशङ्कोस्त्रैराशिकात् ततः ।
छायाकोटी समच्छाये स्यातां पूर्वापरायते ॥ २८२ ॥

नतांशस्यापि तत्तुल्या द्युवृत्तप्रमिता तु सा ।
त्रिज्यावृत्तमिते स्यातां छायाकोटी समप्रभे ॥ २८३ ॥

इति ॥

व्याख्या—1. A. रालज्य ; B. रालं य 2. A. द्युज्या सा

[दशप्रश्नाः]

इह शङ्कु-नत-क्रान्ति-दिगग्रा-ऽक्षेषु पञ्चसु ।
द्वयोर्द्वयोरानयनं दशधा स्यात् परैस्त्रिभिः ॥ ६० ॥

सशङ्कवो नतक्रान्तिदिगक्षाः सनतास्तथा ।
अपक्रमदिगग्राक्षा दिगक्षौ क्रान्तिसंयुतौ ॥ ६१ ॥

दिगक्षाविति नीयन्ते द्वन्द्वीभूयेतरैस्त्रिभिः ॥ ६२a ॥

[प्रश्नः १. अपक्रमा-ऽशाग्रा-ऽक्षैः शङ्कु-नत्यौ]

आशाग्रा लम्बकाभ्यस्ता त्रिज्याभक्ता च कोटिका ॥ ६२b ॥

[दशप्रश्नोत्तरम्]

इह शङ्कुनतेत्यादि (60-62a)—

[शङ्क्वादिपञ्चसु दशप्रश्नानां सङ्कृतिः]

इह त्वाद्येन साध्येन द्वितीयादेः समन्वयात् ।
चत्वारो,ऽथ द्वितीयेन तृतीयादेः समन्वयात् ॥ २८४ ॥

[1]त्रय,स्तथा तृतीयेन कृतपञ्चमयोरपि ।
द्वौ, तुर्यस्यान्त्यसम्बन्धादेकः, प्रश्नास्ततो दश ।
गच्छे चतुष्के त्वेकादिचयसङ्कलितं तु तत् ॥ २८५ ॥

[अपक्रमाशाग्राक्षैः शङ्कुनत्यानयनवासना]

आशाग्रेत्यादि (62b-67)—

एतेषामुत्तरेष्वाद्यैरनुक्तेषु दशस्वपि ।
आदिमस्योत्तरं सूर्यसिद्धान्ते लेशतः कृतम् ।
कोणशङ्कुप्रकरणे शङ्क्वर्थं तद्वचो यथा ॥ २८६ ॥

"त्रिज्यावर्गार्धतोऽग्रज्यावर्गोनाद् द्वादशाहतात् ।
पुनर्द्वादशनिघ्नाच्च यत् फलं लभ्यते बुधैः ॥ २८७ ॥

व्याख्या—1. C. तृतीय for त्रय

भुजाग्रज्या तयोर्वर्गयोगमूलं श्रुतिर्हरः ।
क्रान्त्यग्रवर्गौ तद्वर्गात् त्यक्त्वा कोट्यौ तयोः पदे[1] ॥ ६३ ॥
कुर्यात् क्रान्त्यग्रयोर्घातं कोट्योर्घातं तथा परम् ।
सौम्ये गोले तयोर्योगात् भेदाद् याम्ये तु घातयोः ॥ ६४ ॥

शङ्कुवर्गार्धसंयुक्तविषुवद्वर्गभाजितात् ।
लब्धं तु करणी नाम तां पृथक् स्थापयेत् ततः ॥ २८८ ॥
विषुवच्छायार्कवधावग्रज्यासंगुणात् ततः ।
भक्तात् फलाख्यं तद्वर्गसंयुक्तकरणीपदम् ॥ २८९ ॥
फलेन हीनं संयुक्तं दक्षिणोत्तरगोलयोः ।
याम्ययोर्विदिशोः शङ्कुः एवं याम्योत्तरे रवौ ।
परिभ्रमति शङ्क्वोस्तु शङ्कुरुत्तरयोस्तु सः" ॥ २९० ॥
(सूर्यसिद्धान्तः, त्रिप्रश्नाध्यायः, ३.२८-३२)

इति तन्त्रान्तरश्लोकाः ।

सौम्ययाम्यदिशोः शङ्कुरिष्टो यत्र विदिग्गतः ।
दिगग्राध्यर्धराशिज्या तत्र तद्दिग्गता मता ॥ २९१ ॥
राशित्रयान्तरितयोर्दिशो मध्यगतस्ततः ।
आशाग्रा भत्रयस्यातः कृत्स्नज्यार्धसमा भवेत् ॥ २९२ ॥
ज्याबाणयोर्वर्गयोगात् कृत्स्नज्या हि पदीकृता ।
ज्याबाणौ चक्रपादे तौ त्रिज्यातुल्यौ समौ मिथः ॥ २९३ ॥
अतस्तयोर्वर्गयोगो द्विघ्नत्रिज्याकृतेः समः ।
अस्यार्धराशिज्यावर्गश्चतुर्थोऽशस्ततो भवेत् ॥ २९४ ॥
द्विघ्नवर्गचतुर्थांशस्यार्धवर्गत्वकल्पनात् ।
तत्द्विगुणयोश्चैतद्वर्गक्षेत्रे निदर्श्यताम् ॥ २९५ ॥
त्रिज्यावर्गार्धतुल्यत्वं अध्यर्धज्या[1]कृतेस्ततः ।
द्विघ्नवर्गचतुर्भागो वर्गोऽर्धस्य भवेद् यतः ॥ २९६ ॥

मूलम्— 1. A. om. पदे

व्याख्या—1. A. तुल्यत्वमध्यार्धज्या

आद्यघातेऽधिके सौम्ये योगभेदद्वयादपि ।
त्रिज्याघ्नाद् हारवर्गाप्तः शङ्कुरिष्टदिगुद्भवः ॥ ६५ ॥

लम्बवर्गार्धतुल्योऽसौ लम्बवृत्ते प्रकल्पितः[1] ।
अक्षज्यावर्गसंयुक्ताद्धारो मूलीकृतस्ततः ॥ २९७ ॥
घातः क्रान्त्यक्षयोर्यः स्यात् तत्कोट्योरपि योऽपरः ।
तयोर्योगान्तराच्छङ्कुर्हाराप्तः सौम्ययाम्ययोः ॥ २९८ ॥
वर्गयोगान्तराभ्यां वा हारवर्गोद्धृतो भवेत् ।
हारको लम्बवर्गार्धमक्षवर्गयुतं भवेत् ॥ २९९ ॥
तत्र क्रान्त्यक्षयोः कोट्योर्वर्गघाते चिकीर्षिते ।
स्वस्ववर्गोनिताद्धारवर्गतः कोटिरेतयोः ॥ ३०० ॥
गुण्येऽक्षकोटिवर्गोऽत्र क्रान्तिकोटिकृतो गुणे ।
अल्पता गुणकारस्य क्रान्तिवर्गेण हारकात् ॥ ३०१ ॥
विवरं क्रान्तिवर्गः स्यात्[2] गुणहारकयोस्ततः ।
तद्गुणाद् गुण्यतो हारवर्गाप्तं त्यज्यते फलम् ॥ ३०२ ॥
गुण्यस्य हारादल्पत्वादधिकत्वे पुनः क्षिपेत् ।
स्यादेतदक्षकोट्याश्चेद्वर्गो गुण्येत केवलः[3] ॥ ३०३ ॥
नैवं क्षिप्ताक्षवर्गस्य हारतुल्यत्वकल्पनात् ।
येन क्रान्तिकृतेरेव त्याज्यत्वं परिकल्पितम् ॥ ३०४ ॥
क्रान्तिवर्गस्त[4]तस्तत्र गुणहारान्तरोद्भवः ।
गुण्यस्य हारसाम्यार्थं क्षिप्येताक्षकृतिर्यदा ॥ ३०५ ॥
गुणक्षेपाहृतेर्हारलब्धं त्याज्यं तदा[5] त्यजेत् ।
त्याज्यस्य क्रान्तिवर्गेण तुल्यत्वं प्राक् प्रपञ्चितम् ॥ ३०६ ॥
शङ्कोरितरखण्डेन तुल्यं निस्संशयं च तत् ।
क्रान्त्यक्षयोर्वर्गघाताद् हारवर्गोद्धृतो ह्यसौ ॥ ३०७ ॥

व्याख्या—1. B. प्रकल्पितम् 2. A. वर्गस्य
3. C. केवलम् 4. B. Hapl. om. of स्त
5. A. त्याज्यात्तदा

किन्त्वेतत् त्याज्यतः शुद्धे क्षेप्यमेव फलं भवेत् ।
इतरस्य धनर्णत्वं गोलयोः सौम्ययाम्ययोः ।। ३०८ ।।

अक्षकृत्यूनहाराप्त्याल्लम्बवर्गार्धत[1]स्ततः ।
शोधयेत् क्रान्तिवर्गं स्वलब्धशोध्यफलोनितम् ।। ३०९ ।।

त्रिज्यावर्गार्धतोऽग्रज्या[2]वर्गो यदि विशोध्यते ।
एकवृत्तगतत्वेन द्वयोस्त्रिज्याग्रजीवयोः ।। ३१० ।।

शिष्टं तत्कोटिवृत्तेऽत्र पुनर्विपरिणम्यते ।
शङ्कुखण्डस्य तस्यास्य हारवृत्तगतत्वतः ।। ३११ ।।

त्रिज्यावृत्ते स्फुटः शङ्कुखण्डो विपरिणम्यते ।
कोटिवृत्तगता त्रिज्या हारकत्वेन सम्मता ।। ३१२ ।।

स्ववृत्ते च गुणस्तेन तुल्यत्वादुभयं त्यजेत् ।
लम्बवर्गार्धनिघ्नं तद् हारवर्गेण चोद्धरेत् ।। ३१३ ।।

शङ्कुखण्डकृतिर्लब्धा शङ्कुखण्डः परं[3] ततः ।
अक्षापक्रमयोर्घाताद् हारकाप्तसमोऽपरः ।। ३१४ ।।

स चेवक्षाग्रयोर्घातात् कोटिवृत्ते विधीयते ।
हारवृत्तगतः सोऽयं त्रिज्यावृत्ते विधीयताम् ।। ३१५ ।।

हरणं गुणनं त्यक्त्वा तन्मध्ये त्रिज्ययैकया ।
[4]लम्बघ्नाक्षाग्रसंवर्गान्मूलवर्गहृतोऽपरः ।। ३१६ ।।

शङ्कुखण्डो ययोर्योगान्तराच्छङ्कुः स्फुटो भवेत् ।
अक्षावलम्बको यत्र विषुवत्कर्णगामिनौ ।। ३१७ ।।

तत्र तौ विषुवच्छायौ[5] तच्छङ्कू परिकल्पितौ ।
हारवर्गोऽत्र विषुवच्छायावर्गाङ्गुलान्विता ।। ३१८ ।।

द्वादशाङ्गुलशङ्कोस्तु वर्गार्धं स्याद् द्विसप्ततिः ।
शेषं पूर्ववदन्यत् स्यादिष्टशङ्कौ विविग्गते ।। ३१९ ।।

व्याख्या—1. B. वर्गोद्धृत 2. B. तोर्धज्या
3. B. पदं 4. B. लब्धाघ्नाक्षाग्र
5. A. छाया

छाया तत्कोटिराशाग्राकोटिघ्ना सा द्युजीवया ।
भक्ता नतज्या क्रान्त्यक्षदिगग्राभिर्भवेदिति ॥ ६६ ॥

एवंनीतोऽप्यसौ शङ्कुः क्वचित् सौम्यविदिग्गतः ।
प्रदक्षिणक्रमाद् भ्राम्यन्नेम्यां च विदिशं व्रजेत् ।
प्रत्यक्कपाले विदिशौ व्युत्क्रमात्ते दिगाहृते ॥ ३२० ॥

इति ॥

[नतज्या तद्वासना च]

प्राच्यादिष्टदिगग्रान्ते स्वस्तिकात् क्षितिजाश्रितम् ।
[1]पश्चात् स्वस्तिकतस्तावत्यन्तरे क्षितिजाश्रितम् ॥ ३२१ ॥
इष्टदिङ्मण्डलं तत् स्यात् खमध्यस्पृष्टनेमिकम् ।
तावतान्तरितं चान्यद् याम्योदक्स्वस्तिकद्वयात् ॥ ३२२ ॥
खमध्यस्पृष्टपरिधिर्व्यस्तदिङ्मण्डलं भवेत् ।
क्षितिजव्यस्तदिग्वृत्तसम्पातद्वितयोद्गतम् ॥ ३२३ ॥
ध्रुवद्वितयसंस्पृष्टं तिर्यग्वृत्तं तथापरम् ।
इष्टदिग्घटिकावृत्तद्वयतिर्यग्गतत्वतः ॥ ३२४ ॥
तिर्यग्वृत्तगतं वेद्यं तयोस्तु परमान्तरम् ।
याम्योदग्वृत्ततो व्यस्तदिग्वृत्तस्य यदन्तरम् ॥ ३२५ ॥
क्षितिजस्थं दिगग्रा सा सैव तत्परमान्तरम् ।
याम्योदग्व्यस्तदिग्वृत्तपार्श्वस्थं क्षितिजं यतः ॥ ३२६ ॥
समपार्श्वस्थिते वृत्ते[2] वृत्तयोर्हि परान्तरम् ।
खमध्यतोऽत्र लम्बान्ते तयोरिष्टान्तरं नयेत् ॥ ३२७ ॥
खमध्यतस्तु लम्बान्ते ध्रुवः सौम्यो व्यवस्थितः ।
व्यस्तदिङ्मण्डलस्येष्टान्तरालध्रुवतोऽत्र यत् ॥ ३२८ ॥
सा कोटिस्तद्भुजाक्षज्या तयोर्वर्गयुतेः पदम्[3] ।
स कर्णो ध्रुवतस्तिर्यग्वृत्तस्थं क्षितिजान्तरम् ॥ ३२९ ॥

व्याख्या—1. B. om. the line. 2. A. व्यस्ते
3. A. B. परम्

क्रान्त्यक्षघाते तत्कोट्योर्घाताद् याम्येऽधिके सति ।
[1]नेष्टः शङ्कुर्भवेत् सौम्ये हाराच्चापक्रमेऽधिके ॥ ६७ ॥

इष्टदिङ्मण्डलघटीवृत्तयोस्तत्परान्तरम् ।
क्षितिजव्यस्तदिग्वृत्तसम्पातौ यौ ध्रुवौ च यौ ॥ ३३० ॥

तच्चतुष्टयसंस्पृष्टं वृत्तं तिर्यग्गतं तयोः ।
घटिकावृत्तपार्श्वस्थौ ध्रुवौ द्वावपि सर्वदा ॥ ३३१ ॥

दिग्वृत्तात् क्षितिज[1]व्यस्तदिक्सम्पातौ तथाविधौ ।
तयोः समतिरश्चीनं तिर्यग्वृत्तं ततो भवेत् ॥ ३३२ ॥

अतः समतिरश्चीने वृत्ते तत्र परान्तरम् ।
परान्तरेण दिग्वृत्तव्यासार्धं यदि लभ्यते ॥ ३३३ ॥

अक्षेणेष्टान्तरालेन ततः किं लभ्यते फलम् ।
घटीवृत्तात् खमध्यान्तो ह्यक्षो याम्योत्तरायतः ॥ ३३४ ॥

सम्पाततः खमध्यान्तो घटीदिग्वृत्तयोर्द्वयोः ।
अन्तरालं च दिग्वृत्तगतमिच्छाफलं त्विह ॥ ३३५ ॥

इच्छया भुजया ह्यत्र कर्ण इच्छाफलं भवेत् ।
अक्षस्थानीयमेतत्तु तत्कोटिर्लम्बकस्ततः ॥ ३३६ ॥

तद्वत् क्रान्तिभुजायाश्च फलं तत्कर्णमानयेत् ।
क्रान्तिस्तु घटिकावृत्ताद् द्युवृत्तावधिका[2] भुजा ॥ ३३७ ॥

दिग्वृत्ते घटिकावृत्ताद् द्युवृत्तावधिका श्रुतिः ।
क्रान्त्यक्षफलकोट्यौ तौ[3] त्रिज्यावर्गान्तरात् पदे ॥ ३३८ ॥

अन्योन्यकोटिहतयोस्त्रिज्यया हृतयोर्द्वयोः ।
क्रान्त्यक्षफलयोर्योगभेदाभ्यां भवतीष्टभा ॥ ३३९ ॥

मूलम्— 1. A. नेष्टशङ्कुः

व्याख्या—1. A. द्दिग्वृत्तत् क्षितिज ; B. दिग्वृत्तक्षितिज
2. A. C. Hapl. upto वधिका, next line.
3. A. B. तत् for तौ

[प्रश्नः २. नताशाग्राक्षैः शङ्क्वपक्रमः]

नतलम्बकयोर्घातात् त्रिज्याप्तं तत् स्वदेशजम् ।
स्वदेशनतकोट्याप्तं नताक्षज्यावधात्तु यत् ॥ ६८ ॥

क्रान्तिलम्बोत्थफलयोर्व्यत्ययाद् योगभेदतः ।
इष्टशङ्कुश्च कर्तव्यश्छायावन्योन्यतोऽथ ते ॥ ३४० ॥

इष्टविग्घटिकावृत्तान्तरेण परमेण वा ।
द्युज्यावलम्बका हत्वा त्रिज्यया विभजेदुभौ ॥ ३४१ ॥

लब्धे क्रान्त्यक्षयोः कोट्यौ यद्वा क्रान्त्यक्षयोः कृती ।
परान्तरालवर्गात्तु त्यक्त्वा मूलीकृते उभे ॥ ३४२ ॥

मिथः कोटीहतक्रान्त्यक्षयोर्योगान्तरात् ततः ।
परान्तरालवर्गाप्तौ त्रिज्याघ्नात् भानरावुभौ ॥ ३४३ ॥

याम्यगोलेऽत्र शङ्कुः स्याल्लम्बक्रान्त्यंशभेदतः ।
क्रान्त्यंशकेऽत्र लम्बांशावधिके क्षितिजादधः ॥ ३४४ ॥

शङ्कुः स्यादथ हाराच्चेत् सोऽधिको न तु सम्भवेत् ।
सौम्यगोले तु याम्या चेदग्रा क्रान्त्यंशलम्बयोः ॥ ३४५ ॥

शङ्कुर्योगोद्भवः सौम्या विगग्रा चेत् तदन्तरात् ।
दिङ्मण्डलघटीवृत्तविवरावधिके सति ।
द्युघटीवृत्तविवरे भवेच्छङ्कुर्न तादृशः[1] ॥ ३४६ ॥

इति ॥

[नताशाग्राक्षैः शङ्क्वपक्रमानयनवासना]

नतलम्बकयोरिति (68-73)—

ध्रुवद्वितयसंस्पृष्टं ग्रहाधिष्ठितनेमिकम् ।
नतवृत्तं भवेद् यस्य दक्षिणोत्तरमण्डलात् ॥ ३४७ ॥

घटिकामण्डलगतं कल्प्यते परमान्तरम् ।
नतक्षितिजसम्पातद्वयं स्पृष्टं खमध्यगम् ॥ ३४८ ॥

व्याख्या—1. C. तादृशम्

तदाशाग्रावधे कोट्योस्तयोर्घातं क्षिपेदथ[1] ।
शोधयेद् दक्षिणाग्रायां त्रिज्यया च ततो हरेत् ॥ ६९ ॥

लब्धात् स्वनतकोटिघ्नात् पृथक् त्रिज्याप्तवर्गितम् ।
युक्तं स्वनतवर्गेण तन्मूलेन हृतं फलम् ॥ ७० ॥

वृत्तं द्वितीयं तु नतसममण्डलमीरितम् ।
याम्योदग्वृत्तसम्पातात् क्षितिजे यावदन्तरे ॥ ३४९ ॥

नताख्यसमवृत्तस्य सम्पातोऽथ ततः स्थितम् ।
क्षितिजे वृत्तपादान्ते खमध्यस्फुटनेमिकम् ॥ ३५० ॥

नतवृक्षेपवृत्तेऽन्तर्यत्र स्यात् परमान्तरम् ।
नतक्षितिजयोस्तद्वन्नततत्समवृत्तयोः ॥ ३५१ ॥

स्वदेशनतकोटिश्च तद्भुजा चेति ते उभे ।
दिग्वृत्तव्यस्तदिग्वृत्ते पूर्ववत् परिकल्पयेत् ॥ ३५२ ॥

नतवृत्तं खमध्यात्तु नतवृक्षेपमण्डले ।
यावन्नतं स्यात् तत्पार्श्वं क्षितिजात् तावदुन्नतम् ॥ ३५३ ॥

क्षितिजव्यस्तदिग्वृत्तसम्पातद्वितयोद्गतम् ।
नतेष्टदिङ्मण्डलयोः समतिर्यग्गतं तथा ॥ ३५४ ॥

नतपार्श्वोन्नतिस्पृष्टं तिर्यग्वृत्तं प्रचक्षते ।
तिर्यग्वृत्तस्य दिग्वृत्ते क्षितिजादुन्नतिस्तु या ॥ ३५५ ॥

तत्रैव नतवृत्तस्य खमध्यात् तावती नतिः ।
छाया सा नतवृत्तस्य सम्पातान्ता खमध्यतः ॥ ३५६ ॥

तत्सम्पाते ग्रहस्तस्मात् तत्कोटिः शङ्कुरिष्यते ।
समन्तात् क्षितिजादूर्ध्वं यत्स्वदेश[1]नतान्तरे ॥ ३५७ ॥

वृत्तस्वनतकोट्याख्यं नतवृत्तस्य नाभिगम् ।
दक्षिणोत्तरवृत्ते यन्नभोमध्यध्रुवान्तरम् ॥ ३५८ ॥

मूलम्— 1. $C_{7\cdot9\cdot10}$ क्षिपेदुदक्

व्याख्या—1. B. सवेश

पृथक्कृताद् भवेच्छङ्कुः, छाया तत्कोटिका भवेत् ।
छायाग्रकोटिसंवर्गाद् द्युज्या लब्धा नतज्यया ॥ ७१ ॥

नतज्याद्युज्ययोस्तद्वत् छायाकोटित्रिजीवयोः ।
छायादिगग्राकोट्योश्च घात एको भवेत् ततः ॥ ७२ ॥

द्वयोरेकेन विहृतस्तत्सम्बन्धीतरो भवेत् ।
द्युज्यात्रिजीवयोर्वर्गभेदमूलमपक्रमः ॥ ७३ ॥

स लम्बोऽस्मान्नतज्याघ्नात् त्रिज्याप्तं स्वनतं भवेत् ।
नतवृत्तक्षितिजयोस्तत्कोटिः परमान्तरम् ॥ ३५९ ॥

स्वदेशनतकोट्याप्तमक्षाद् यत् त्रिज्यया हतात् ।
नतक्षितिजसम्पाताद् ध्रुवस्य विवरं तु तत् ॥ ३६० ॥

नतवृत्तगतं तत्तु नतघ्नं त्रिज्यया हरेत् ।
क्षितिजे नतयाम्योदग्वृत्तयोर्लब्धमन्तरम् ॥ ३६१ ॥

योगभेदौ तयाशाग्राकोट्योः कार्यौ तथाविधि ।
अन्योन्यकोटिगुणनात् त्रिज्यया हरणादपि ॥ ३६२ ॥

क्षितिजे नतिदिङ्मण्डलान्तरालं तु तद् भवेत् ।
क्षितिजे नतिदृक्क्षेपविदिग्वृत्तान्तरं च तत् ॥ ३६३ ॥

नतकोट्या स्वया हत्वा त्रिज्यया विभजेत् तु तत् ।
वृत्ते स न[त]कोट्युक्ते[1] नतदृक्क्षेपमण्डलात् ॥ ३६४ ॥

विदिग्वृत्तान्तरं[2] कोटिरेषा स्यात् स्वनतं भुजा ।
तिर्यग्वृत्तगतः कर्णः तयोर्वर्गयुतेः पदम् ॥ ३६५ ॥

नतदृक्क्षेपवृत्तात्तु क्षितिजस्यान्तरं च[3] सः ।
तद्दोःकोट्यौ त्रिजीवाघ्ने कर्णेन विभजेत् फले ॥ ३६६ ॥

स्यातां विङ्मण्डले ते द्वे क्षितिजाच्च खमध्यतः ।
तिर्यग्वृत्तस्यान्तराले छायाशङ्कू च ते क्रमात् ॥ ३६७ ॥

व्याख्या—1. Mss. read न कोट्युक्ते　　2. A. वृत्ता ततः for वृत्तान्तरं
3. B. तु for स

छायाशङ्कू च ते स्यातामिष्टदिङ्मार्गगे उभे ।
भाशाग्राकोटिगुणितां हरेच्छायां नतज्यया ॥ ३६८ ॥

द्युज्या भवेद् यतो घाते नतज्याद्युज्ययोस्तु यः ।
छायाग्राकोटिघातोऽसौ भाकोटित्रिज्ययोरपि ॥ ३६९ ॥

तुल्यरूपात् ततो घाताद् द्वन्द्वेऽन्यतरोद्धृतः ।
तत्सम्बन्धी तदितरो भवतीत्युपपद्यते ॥ ३७० ॥

अग्रा[1]कोटिर्हि दिग्वृत्तदक्षिणोत्तरवृत्तयोः ।
अन्तरालं परं तत्र छायाकोटिश्च तादृशी ॥ ३७१ ॥

क्षितिजस्था भवेदाद्या छायाकोटिर्ग्रहावधिः ।
यथा दिगग्रा दिग्वृत्तात् समवृत्तान्तरं परम् ॥ ३७२ ॥

तथा च्छायाभुजापि स्यात् तत एव ग्रहावधिः ।
अग्रा कोटिहता त्रिज्या च्छायया ह्रियते यदा ॥ ३७३ ॥

छायाकोटिर्यतस्त्रिज्याच्छाययोः कर्णरूपता ।
द्युवृत्ते नतभागज्या त्रिज्यावृत्तमिता च सा ॥ ३७४ ॥

स्ववृत्तप्रमिता सैव नतज्या भवति स्फुटा ।
त्रिज्यातुल्या भवेद् द्युज्या स्ववृत्तप्रमिता यतः ॥ ३७५ ॥

छायाकोटिहता त्रिज्या भक्ता द्युज्या नतज्यया ।
यादृशो नियमस्त्रिज्याद्युज्ययोः स्यात् परस्परम् ॥ ३७६ ॥

तादृशो नियमो वेद्यश्छायाकोटिनतज्ययोः ।
अग्रा कोटिहता च्छाया त्रिज्यया ह्रियते यदा[2] ॥ ३७७ ॥

लब्धं त्रिज्याहतं भूयो ह्रियते च नतज्यया ।
त्यक्त्वा गुणं च हारं च यदि वा त्रिज्ययैकया ॥ ३७८ ॥

अग्रा कोटिहता च्छाया परं हार्या नतज्यया ।
तत्र द्युज्या भवेल्लब्धा तत्कोटिः क्रान्तिरिष्यते ॥ ३७९ ॥

व्याख्या—1. A. Hapl. om. from अग्रा to दिगग्रा, in the fourth line below.

2. A. C. ततः

[प्रश्नः ३. नतापक्रमाक्षैः शङ्क्वाशाग्रे]

नतकोट्या हता द्युज्या विभक्ता त्रिभजीवया ।
सौम्ययाम्यदिशोर्भूज्यायुतोना लम्बकाहता ॥ ७४ ॥
त्रिज्याप्ता शङ्कुराशाग्रा, कोटिर्द्युज्या च पूर्ववत् ॥ ७५a ॥

[प्रश्नः ४. नतक्रान्त्याशाग्राभिः शङ्क्वक्षौ]

छायां नीत्वाथ तत्कोटिद्युज्यावर्गान्तरात् पदम् ॥ ७५b ॥

मूलीकरणतस्त्रिज्याद्युज्ययोर्वर्गभेदतः ।
इत्थं नतदिगग्राक्षैः शङ्क्वपक्रमयोर्विधिः ॥ ३८० ॥

इति ॥

[नतापक्रमाक्षैः शङ्क्वाशाग्रानयनवासना]

नतकोट्येति (74-75a) —

ग्रहावधिर्नतज्या स्याद् दक्षिणोत्तरमण्डलात् ।
छायाकोटिसमा ह्येषा द्युवृत्तस्था सदा भवेत् ॥ ३८१ ॥

सैव स्ववृत्तप्रमिता नतज्या परिकीर्त्यते ।
उन्मण्डलाच्च तत्कोटिरुन्नतज्योपरिस्थिता ॥ ३८२ ॥

क्षितिजावधिकत्वार्थं क्षितिज्याऽस्यां विधीयते ।
ऋणं धनं च क्रमतो गोलयोर्याम्यसौम्ययोः ॥ ३८३ ॥

लम्बकघ्नोन्नतज्या सा त्रिज्यया विहृता स्फुटा ।
भवेदिष्टान्तरालज्या क्षितिजेष्टद्युवृत्तयोः ॥ ३८४ ॥

स एव शङ्कु,स्तत्कोटिश्छाया, द्युज्यानतज्ययोः ।
संवर्गात् छायया भक्ता दिगग्राकोटिरिष्यते ॥ ३८५ ॥

इति ॥

[नतक्रान्त्याशाग्राभिः शङ्क्वक्षानयनवासना]

छायां नीत्वेति (75b-78a)—

भाकोटित्रिज्ययोर्भाग्राकोट्योर्द्युज्यानतज्ययोः ।
मिथो घातत्रयस्यात्र तुल्यत्वं प्राक् प्रदर्शितम् ॥ ३८६ ॥

तच्छायाबाहुघातो यः शङ्कुक्रान्त्योर्वधोऽपि यः ।
क्रान्त्यग्रयोस्तुल्यदिशोस्तयोर्भेदोऽन्यथा युतिः ॥ ७६ ॥
उन्मण्डलक्षितिजयोरन्तरेऽर्के च तद्युतिः ।
तद्धृतां विभजेत् त्रिज्यां तच्छायाकोटिवर्गयोः ॥ ७७ ॥
अन्तरेण भवेदक्षो नताद्यैर्विदितैस्त्रिभिः ॥ ७८[a] ॥

त्रिषु द्वयेष्वन्यतरभक्तस्तदितरो यतः ।
क्रान्तिकोटिं ततो द्युज्यां नतज्यानिहतां हरेत् ॥ ३८७ ॥

अग्रा कोटचा भवेच्छाया तत्कोटिस्त्रिज्ययोद्धृता ।
वर्गान्तरपदं त्रिज्याच्छाययोः शङ्कुरिष्यते ॥ ३८८ ॥

छायातत्कोटिकावर्गमूलभेदं च तद्भुजा ।
छायाघ्नाया दिगग्राया स्त्रिज्याभक्ताथवा भुजा ॥ ३८९ ॥

भाकोटयन्तरितं याम्योत्तरवृत्तात् समन्ततः ।
द्युवृत्तवत्तत्पार्श्वस्थं वृत्तं यत्परिकल्पितम् ॥ ३९० ॥

अक्षस्तत्र घटीवृत्तात् समवृत्तान्तरं भवेत् ।
द्युवृत्तविवरं क्रान्तिघटिकामण्डलात् ततः ॥ ३९१ ॥

छायाभुजात्र विवरं द्युवृत्तसमवृत्तयोः ।
भाकोटिद्युज्ययोर्वर्गभेदतो यत् पदं भवेत् ॥ ३९२ ॥

क्रान्तिकोटिर्भवेद् यत्र तादृग्वृत्तं प्रकल्प्यते ।
व्यासार्धं यस्य भाकोटित्रिज्यावर्गान्तरात् पदम् ॥ ३९३ ॥

तत्तच्छाया[1]भुजाशङ्क्वोर्वर्गयोगपदं भवेत् ।
तदेव तत्र व्यासार्धं यत्तद् वृत्तान्तरं कृतम् ॥ ३९४ ॥

छाया हि स्वभुजाकोटयोर्वर्गयोगपदं भवेत् ।
शङ्कुच्छायाकृतियुतेर्मूलं त्रिज्या च सम्मता ॥ ३९५ ॥

छायायाः कोटिबाहू द्वौ तच्छङ्कुरिति ये त्रयः ।
तेषां त्रयाणां वर्गैक्यं सम्यक् त्रिज्याकृतौ स्थितम् ॥ ३९६ ॥

व्याख्या —1. A. ततश्छाया

[प्रश्नः ५. शङ्क्वाशाग्राक्षैः नतापक्रमौ]

अक्षशङ्क्वोर्वधो यश्च यश्च भाग्राहुलम्भयोः ॥ ७८^{b} ॥

शङ्कुच्छायाभुजावर्गयोगे तस्माच्चिकीर्षिते ।
छायाकोटिकृतिस्त्रिज्यावर्गतोऽत्र विशोध्यते ॥ ३९७ ॥

क्रान्तिवर्गे ततस्त्यक्ते तत्कोट्याः शिष्यते कृतिः ।
सा च द्युज्याकृतेश्छायाकोटिवर्गे विशोधिते ॥ ३९८ ॥

छायाभुजायाः कोटिश्च तच्छङ्कुरिह सम्मतः ।
यतस्तयोर्वर्गयोगमूलं व्यासार्धमिष्यते ॥ ३९९ ॥

छायाभुजाक्रान्तिकोट्योः शङ्कुक्रान्त्योश्च घातयोः ।
क्रान्त्यग्रयोर्विशोर्भिन्नतुल्ययोर्योगभेदतः ॥ ४०० ॥

उन्मण्डलक्षितिजयोरन्तरस्थरवेर्युतेः ।
अक्षस्तदीयव्यासार्धभक्तस्तद्वृत्तगो भवेत् ॥ ४०१ ॥

त्रिज्यया निहतो भूयस्तद्व्यासार्धो हृतः स्फुटः ।
मिथः कोटिहृते यद्वा क्रान्तिच्छायाभुजे उभे ॥ ४०२ ॥

योगान्तरात् तयोरक्षो हारवर्गोद्धृतः स्फुटः ।
छायायां याम्यदिक्कायां याम्यदिक्त्वेऽप्यपक्रमे ॥ ४०३ ॥

तयोर्भेदो भवेदक्ष इति प्रागेव वर्णितम् ।
क्रान्त्यर्कनतिभेदोऽक्षो याम्ये प्रागुदितो यतः ॥ ४०४ ॥

अग्रा याम्या सौम्यदिक्का क्रान्तिश्चेद्योग इष्यते ।
उन्मण्डलक्षितिजयोर्मध्ये दृश्ये च भास्करे ।
उभयोः क्रान्तिभाबाह्वोः योग एवाक्ष इष्यते ॥ ४०५ ॥

इति ।

[शङ्क्वाशाग्राक्षैः नतापक्रमानयनवासना]

[1]अक्षशङ्क्वोर्वध इति (78b-79)—

स्ववृत्तगामिनी च्छायाभुजा सर्वत्र दृश्यते ।
छायाबाहुभुजं यत् स्याद् व्यासार्धं शङ्कुकोटिकम् ॥ ४०६ ॥

व्याख्या—1. The Mss. read the *pratīka* as अशङ्कुवध इति ।

[1]सौम्ययाम्यस्थिते भानौ तयोर्योगान्तरात् ततः ।
क्रान्तिस्त्रिज्याहृता प्राग्वन्नतज्यां च समानयेत् ॥ ७९ ॥

सौम्यगोले भवेत् क्रान्तिर्योगश्छायाभुजाक्षयोः ।
याम्यगोले तयोर्भेद इति प्रागेव वर्णितम् ॥ ४०७ ॥

त्रिज्यावृत्तगताक्षज्या सर्वत्र परिकल्प्यते ।
छायाभुजा सा सर्वत्रापीष्टवृत्तगता भवेत् ॥ ४०८ ॥

छायाभुजाक्षौ कर्तव्याविष्टवृत्तगतावुभौ ।
योगान्तरात्तयोरिष्टक्रान्तिरानीयते यतः ॥ ४०९ ॥

छायाभुजायाः कोटिश्च स्ववृत्ते शङ्कुरिष्यते ।
त्रिज्यावृत्तगताक्षस्य कोटिर्लम्बोऽपि वर्णितः ॥ ४१० ॥

छायाभुजायाः कर्तव्या त्रिज्यावृत्तगतिस्ततः ।
त्रिज्यया गुणनाद् वृत्तव्यासार्धहरणादपि ॥ ४११ ॥

भूयो लम्बेन निहता त्रिज्यया च विभज्यताम् ।
लम्बघ्ना वा स्ववृत्तस्य व्यासार्धेनोद्धृता स्फुटा ॥ ४१२ ॥

गुणनं हरणं चापि विधूय त्रिज्ययैकया ।
येन साक्षज्यया योगवियोगापादनक्षमा ॥ ४१३ ॥

अक्षज्यामपि तां हत्वा तत्कोट्या शङ्कुतुल्यया ।
हरेत् स्ववृत्तव्यासार्धेनाद्येनैव फलं स्फुटम् ॥ ४१४ ॥

योगभेदकृता क्रान्तिस्तयोः स्यात् सौम्ययाम्ययोः ।
अतः शङ्कुहृताक्षज्या भाबाहुर्लम्बकाहतः ॥ ४१५ ॥

योगभेदात्तयोः क्रान्तिरिष्टा व्यासार्धसंहृता ।
अग्राशङ्क्वोस्तथा च्छायाग्राकोट्योरपि घाततः ।
भाकोटित्रिज्ययोर्घाद्वा नतज्या द्युज्ययोद्धृता ॥ ४१६ ॥

मूलम्—1. A. B. C_9 स्फुटार्के सौम्ययाम्यस्थे

[प्रश्नः ६. शङ्क्वग्रपक्रमाक्षैः नताशाग्रे]

त्रिज्यापक्रमघातो यो यश्च शङ्क्वग्रयोर्वधः ।
तयोर्योगान्तरं यत्तु गोलयोर्याम्यसौम्ययोः ॥ ८० ॥
भाबाहुर्लम्बकाप्तोऽस्मात् त्रिज्याघ्नाद् भाहृतेष्टदिक् ॥ ८१[a] ॥

[प्रश्नः ७. शङ्क्वग्रपक्रमाशाग्राभिः नताक्षौ]

वर्गान्तरपदं यत् स्यात् छायाकोटिद्युजीवयोः ॥ ८१[b] ॥

[शङ्क्वग्रपक्रमाक्षैः नताशाग्रयोरानयनवासना]

त्रिज्यापक्रमघात इति (80-81a)—

यथा त्रिज्याघ्नभाकोटया नतज्या द्युज्ययोद्धृता ।
तथा विस्पष्टमेवैतत्तत्र तत्र प्रदर्शितम् ॥ ४१७ ॥

शङ्क्वग्रार्काग्रयोर्योगभेदात् छायाभुजा भवेत् ।
शङ्क्वग्रं तन्महाशङ्कोरक्षघ्नाल्लम्बकोद्धृतम् ॥ ४१८ ॥

अर्काग्रादोर्गुणावन्त्यक्रान्तिघ्नाल्लम्बकोद्धृता ।
लम्बकोद्धरणात् पूर्वं तयोरन्योन्यशेषता ॥ ४१९ ॥

तत्रापक्रमतोऽर्काग्रा त्रिज्याघ्ना लम्बकोद्धृता ।
इति त्रिज्याहतक्रान्तेः शङ्कोरक्षहृतस्य च ॥ ४२० ॥

योगभेदात् तयोर्याम्यसौम्ययोर्गोलयोः क्रमात् ।
भाबाहुर्लम्बकाप्तोऽस्मात् त्रिज्याघ्नाद् भाहृतेऽष्टदिक् ॥ ४२१ ॥

[शङ्क्वग्रपक्रमाशाग्राभिः नताक्षयोरानयनवासना]

वर्गान्तरपदमिति (81b-83a)—

भाकोटिद्युज्ययोर्वर्गभेदमूलं तु यद्भवेत् ।
उन्मण्डलाद् द्युवृत्तज्या त्रिज्यावृत्तमितोर्ध्वगा ॥ ४२२ ॥

क्षितिज्यया‍धिका याम्ये सौम्ये सा स्यात् तदूनिता ।
क्षितिजादधऊर्ध्वस्थं यस्मादुन्मण्डलं तयोः ॥ ४२३ ॥

तच्छायाबाहुयोगो यः शङ्कुक्रान्त्यैक्यवर्गतः ।
तेनाप्तं यत् फलं तस्मिन्नेव तत् स्वमृणं पृथक् ॥ ८२ ॥
तयोरल्पहृता त्रिज्या महताऽऽप्तात्तमौर्विका ॥ ८३[a] ॥

क्षेत्रद्वयगतत्वेन तत्र दोःकर्णयोर्युतिः ।
याम्यगोलोन्नतज्यायां स्यात् क्षितिज्याधिकत्वतः ॥ ४२४ ॥

उन्नतज्या क्षितिज्यातः कर्णतां भजते क्वचित् ।
अधोगता क्षितिज्या या सैवान्यत्र भुजा भवेत् ॥ ४२५ ॥

अतस्तत्रोन्नतज्यायां वेद्या दोःकर्णयोर्युतिः ।
छायाबाहुर्यदा तस्यां क्षिप्यते याम्यविग्भवः ॥ ४२६ ॥

तस्यापि शङ्क्वग्रार्काग्रायोगरूपतया स्थितेः ।
कर्णोऽर्काग्रात् क्षितिज्या तद्भुजाकोटिरपक्रमः ॥ ४२७ ॥

शङ्क्वग्रं च भुजारूपं[1] यत्क्षेत्रं शङ्कुकोटिकः[2] ।
तयोर्योगे ततः कर्णकोट्योर्योगावुभौ स्थितौ ॥ ४२८ ॥

क्षेत्रयोस्तद् द्वयं तुल्यस्वभावं च भवेन्मिथः ।
एवं दोःकर्णयोर्योगद्वयं याम्ये प्रदर्शितम् ॥ ४२९ ॥

सौम्यगोले तु दोःकर्णविवरद्वितयं स्थितम् ।
याम्ये गोले तु तद्योगे सौम्ये च विदितेऽन्तरे ॥ ४३० ॥

वर्गान्तरं च दोःश्रुत्योर्नृक्रान्त्यैक्यकृतिर्भवेत् ।
शङ्क्वग्रादुत्तरार्काग्रा यदा न्यूना भवेत् तदा ॥ ४३१ ॥

शङ्कुक्रान्त्यन्तरकृतिः प्रोक्ते वर्गान्तरं भवेत्[3] ।
योगान्तराभ्यासकृतशङ्कुक्रान्तिकृतिर्भवेत् ॥ ४३२ ॥

ततो दोःकर्णयोगेन हृत्वा लब्धं तदन्तरम् ।
वर्गान्तराद् द्वयोर्योगभक्तो भेदो भवेद् यतः ॥ ४३३ ॥

व्याख्या—1. A. शङ्क्वग्रा भुजारूपं ; C. शङ्ग्राण्यभुजारूपं
2. C. कोटिका
3. A. C. Hapl. after भवेत् to भवेत् , next line.

[प्रश्नः ८. शङ्कुनताक्षैः अपक्रमाग्राप्ते]

त्रिज्याहताक्षशङ्कू स्वनतकोट्योर्धृतौ पृथक् ॥ ८३b ॥

ये तत्कोट्यौ च तत्त्रिज्यावर्गभेदपदीकृते[1] ।

मिथः कोटिघ्नयोर्योगाद् याम्ये सौम्येऽन्तरात् तयोः ॥ ८४ ॥

ततो दोःकर्णभेदेन हृत्वा तद्योग आप्यते ।

वर्गान्तराद् भेदभक्तो राश्योर्योगो भवेद् यतः ॥ ४३४ ॥

योगेऽन्तरे च विदिते स्यातां सङ्क्रमणावुभौ ।

तत्राद्यो द्विगुणः कर्णो द्वितीयो द्विगुणा भुजा ।

त्रिज्याकर्णे ततस्ताभ्यामक्षस्त्रैराशिकाद् भवेत् ॥ ४३५ ॥

इति ॥

[शङ्कुनताक्षैः अपक्रमाग्राप्त्योरानयनवासना]

त्रिज्याहृतेति (83b-87) —

इष्टशङ्कुस्वदेशाक्षौ त्रिज्यया निहतौ पृथक् ।

स्वदेशनतकोट्याप्तौ तत्त्रिज्यावर्गभेदतः ॥ ४३६ ॥

मूलान्नीत्वा तयोः कोट्योः स्वान्यकोटिहृतौ च तौ ।

नतमण्डलवृत्यार्धमध्याद् याम्योत्तरे रवौ ॥ ४३७ ॥

तयोर्योगान्तरात् त्रिज्याभक्ता द्युज्या भवेदिह ।

द्युज्यात्रिजीवयोर्वर्गभेदात् क्रान्तिर्न दुष्करा ॥ ४३८ ॥

स्वदेशनतकोट्याप्तं शङ्कोस्त्रिज्याहतात् फलम् ।

नतवृत्तगतं तत्तु क्षितिजद्युगतान्तरम् ॥ ४३९ ॥

ताभ्यां तु गुणहाराभ्यां तद्वदक्षाच्च यत्फलम् ।

नतवृत्तगतं तत्तु स्याद् ध्रुवक्षितिजान्तरम् ॥ ४४० ॥

सौम्याद् ध्रुवार्कविवरं तयोर्विश्लेषसम्मितम् ।

याम्यध्रुवार्कान्तरालं तद्वत् तद्योगसम्मितम् ॥ ४४१ ॥

मूलम्—1. $C_{1-8\cdot10}$ पदीकृतौ

त्रिज्यया विहृता द्युज्या क्रान्त्याशाग्रे तु पूर्ववत् ।
नतमण्डलदृश्यार्धमध्यतः सौम्ययाम्यता ॥ ८५ ॥

[प्रश्नौ ९-१०. अपरैस्त्रिभिः क्रान्त्यक्षौ, आशाग्राक्षौ च]

दिगग्रायास्तु तत्कोटिस्तच्छायाघाततो हृता ।
नतज्यया भवेद् द्युज्या, तद्भुजा क्रान्तिरेव हि ॥ ८६ ॥

द्युज्यानतज्ययोर्घातादग्राकोटिः प्रभाहृता ।
अक्षः प्राग्वदिति प्रश्नदशकोत्तरमीरितम् ॥ ८७ ॥

द्युज्यावार्कतदासन्नध्रुवयोर्विवरं भवेत् ।
नतवृत्ते भवेत् क्रान्तिघटिकार्कान्तरं तथा ॥ ४४२ ॥

द्युज्यानतसंवर्गात् त्रिज्याभक्ता प्रभाकोटिः ।
तच्छायावर्गान्तरमूलं छायाभुजा कथिता ॥ ४४३ ॥

छायाभुजा त्रिभज्यानिहता छायोद्धृता दिगग्रा स्यात् ।
तदभिप्रायेणोक्तं क्रान्त्याशाग्रे तु पूर्ववदितीह ॥ ४४४ ॥

[शङ्कुनताशाग्राभिः क्रान्त्यक्षयोरानयनस्य, शङ्कुनतापक्रमैः
आशाग्राक्षयोरानयनस्य च वासना]

दिगग्रायास्तु या कोटिः[1] सिद्ध्येत् छाया स्वशङ्कुतः ।
छायादिगग्राकोट्योश्च घातान्नतगुणोद्धृता ॥ ४४५ ॥

द्युज्या स्यात् तद्भुजारूपा क्रान्तिज्या च भवेत् ततः ।
नतज्याद्युज्ययोर्घातादग्रा कोटिः प्रभोद्धृता ॥ ४४६ ॥

तत्त्रिज्यावर्गविश्लेषाद् दिगग्रा च पदं भवेत् ।
चतुर्थे सप्तमे चापि प्रश्नेऽक्षज्या स्फुटोदिता ॥ ४४७ ॥

छायाकोटित्रिज्यावर्गान्तरमूलककर्णके वृत्ते ।
क्रान्त्योश्छायाबाहुस्वेतरकोटिघ्नयोर्युतिर्वियुतिः ॥ ४४८ ॥

व्याख्या—1. C. तत्कोटिः

[इष्टदिक्छाया]

दिगग्रा विहृता यद्वा तत्कोटिघ्ना पलप्रभा ।
तत्कोटिका तयोः कृत्योर्योगमूलं स्वदृग्गुणः ॥ ८८ ॥
शङ्कुदृग्गुणयोः कृत्योः छायाकर्णो युतेः पदम् ।
शङ्कुच्छाये त्रिजीवाघ्ने छायाकर्णहृते स्फुटे ॥ ८९ ॥

क्रान्त्यग्राविग्भेदे साम्येऽथोन्मण्डलादधश्च युतिः ।
त्रिज्याहतस्तदीयश्रुतिकृतिभक्तो भवेदक्षः ॥ ४४९ ॥

छायाकोटित्रिज्या[1]वर्गान्तरमूलभाभुजायोगः ।
शङ्कुक्रान्त्यैक्यकृतेस्तेनाप्ते हारकं पृथक् स्वर्णम् ।
स्वल्पेन महता त्रिज्या महता भक्ता भवेद् वाक्षः ॥ ४५० ॥

इति ॥

[इष्टदिक्छायानयनवासना]

दिगग्राविहृतेति (88-91)—

इष्टच्छाया[2]कृते वृत्ते छायाकोटिभुजे उभे ।
स्यातां दिगग्रातत्कोट्यौ त्रिज्यावृत्ते प्रवर्तिते ॥ ४५१ ॥

शङ्क्वग्रार्काग्रयोश्छायाभुजा योगान्तरं भवेत् ।
छायातद्भुजयोश्छायाकोटिर्वर्गान्तरात् पदम् ॥ ४५२ ॥

छाया भवेद् भुजाकोट्योर्वर्गयोगपदं ययोः ।
छायाकर्णो भवेच्छायाशङ्क्वोर्वर्गयुतेः पदम् ॥ ४५३ ॥

[3]शङ्क्वग्रार्काग्रयोश्छायाबाहुर्योगो भवेद् यदा ।
तत्तुल्यत्वाद् द्वयोस्तस्मिन्नक्षापक्रमभागयोः ॥ ४५४ ॥

तत्कोटिद्वयसंयोगाच्छायाकोटिर्भवेत् तदा ।
तत्कर्णयोगतस्तत्र च्छाया तत्कर्णरूपिणी ॥ ४५५ ॥

व्याख्या—1. A. द्युज्या for त्रिज्या 2. A. C. इष्टा च्छाया

3. A. Tr. this two lines above.

दृग्गुणाभिहतक्रान्तेरक्षज्याप्तो ह्यपक्रमः ।
क्रान्तिदृग्गुणयोः कोटिस्त्रिज्यावर्गान्तरात् पदम् ॥ ९० ॥

मिथः कोटिहतत्रिज्याभक्तयोः[1] क्रान्तिदृग्ज्ययोः ।
तयोर्योगान्तरं छायागोलयोर्याम्यसौम्ययोः ॥ ९१ ॥

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[1]अक्षखण्डानुसारित्वात्[2] क्रान्तिखण्डस्य सर्वतः ।
[3]तयोरन्योन्यबोधत्वादक्षापक्रमखण्डयोः ॥ ४५६ ॥

[4]ततस्त्रैराशिकेनैव सिद्ध्येदन्योन्यतो द्वयम् ।
छायाशङ्क्वोर्वर्गयोगाच्छायाकर्णः पदं भवेत् ॥ ४५७ ॥

तुल्यरूपतया च्छायाकर्णत्रिज्योस्थवृत्तयोः[5] ।
द्वयोर्दोःकोटिकर्णानां सिद्धिस्त्रैराशिकान्मिथः ॥ ४५८ ॥

अतो दिगग्रातत्कोटयोः सिद्धैः क्षितिजसंस्थयोः ।
वृत्तान्तरे तयोः सिद्धिरनुपातान्न दुष्करा ॥ ४५९ ॥

छायावृत्तेऽथ तद्बाहुरक्षः शङ्क्वग्रसम्मितः ।
द्वादशाङ्गुलशङ्कौ तच्छङ्क्वग्रं विषुवत्प्रभा ॥ ४६० ॥

साध्या तत्कोटिराशाग्राकोटिभ्यामनुपाततः ।
स्यातां दिगग्रातत्कोट्यौ क्षितिजस्थे उभे यतः ॥ ४६१ ॥

छाया च स्वभुजाकोट्योर्वर्गयोगपदं भवेत् ।
शङ्कुच्छायाकृतियुतेश्छायाकर्णः पदं भवेत् ॥ ४६२ ॥

शङ्कुच्छाये त्रिजीवाघ्ने छायाकर्णहृते[6] स्फुटः ।
त्रिज्यावृत्तगते तद्वच्छायाक्रान्त्यंशकं नयेत् ॥ ४६३ ॥

मूलम्— 1. A. B. लब्धयोः for भक्तयोः

व्याख्या—1. B. आक्ष 2. B. सारित्वं
3. A. द्वयोरन्योन्य 4. A. तत्रस्तै ; C. तत्रस्थैः
5. A. त्रिज्योत्थयोर्द्वयोः 6. B. स्फुटे for हृतेः

[कोणशङ्कुच्छाया]

भुजाऽक्षो, लम्बवर्गार्धमूलं कोटिः, श्रुतिस्तयोः ।
हारः, क्रान्तिघ्नकोट्योश्च दोःश्रुत्योः क्रान्तिहारयोः ॥ ९२ ॥

कोटिघ्नाक्षस्य चाप्तैक्यं याम्ये भेद उदक्प्रभा ।
अक्षकोट्यधिकायां तु क्रान्त्यां योगोऽप्युदक्प्रभा ॥ ९३ ॥

क्रान्त्यक्षयोश्च तत्कोट्योर्वधाद् भेदयुती नरः ।
तद्वद् द्विरुदगन्यत्राप्यभावः कोणयोर्द्वयोः ॥ ९४ ॥

अर्कघ्ने भाश्रुती शङ्कुभक्ते ते अङ्गुलात्मिके ॥ ९५a ॥

मिथः कोटिघ्नयोर्योगस्तयोः क्रान्त्यक्षभागयोः ।
व्यासार्धाप्ते[1] प्रभा याम्ये, सौम्ये गोले तथान्तरात् ।
इष्टच्छायाविधौ चैष न्यायो गोलविदां मतः ॥ ४६४ ॥

इति ।

[कोणशङ्कु-च्छायानयनवासना]

भुजाक्ष इति (92-95a)—

आशाप्राच्यर्धराशिज्या कोणशङ्कुप्रभाविधौ ।
लम्बवर्गार्धमूलं तु सा पुनः कोटिवृत्तगा ॥ ४६५ ॥

कोटिः साक्षो भुजाकर्णौ वर्गयोगपदं तयोः ।
हारकः स पुनः क्रान्त्यक्षयोः कोटिघ्नयोर्मिथः ॥ ४६६ ॥

क्रान्त्यक्षकोट्यो तत्कर्णवर्गभेदपदोद्भवे ।
तत्र लब्धफलैक्यं यत् स्याच्छाया याम्यगोलगा ॥ ४६७ ॥

भेदस्तयोः सौम्यगोले छायेति प्राक् प्रदर्शितम् ।
अक्षकोट्यधिका क्रान्तिर्यदोदग्गोलगामिनी ॥ ४६८ ॥

व्याख्या—1. A. C. व्यासार्धाप्ता

[प्राग्लग्नम्]

संस्कृतायनभानूत्थराशिगन्तव्यलिप्तिकाः ॥ ९५[b] ॥
तद्राशिस्वोदयप्राणहता राशिकलाहृताः ।
असवो राशिशेषस्य गतासुभ्यस्त्यजेच्च तान् ॥ ९६ ॥
उत्तरोत्तरराशीनां प्राणाः शोध्याश्च शेषतः ।
पूरयित्वा रवे राशिं क्षिपेद् राशींश्च तावतः ॥ ९७ ॥
विशुद्धा यावतां प्राणाः शेषात्[1] त्रिंशद्गुणात् पुनः ।
तदूर्ध्वराशिमानाप्तान् भागान् क्षिप्त्वा रवौ तथा ॥ ९८ ॥
षष्टिघ्नाच्च पुनः शेषात्[2] तन्मानाप्तकला अपि ।
एवं प्राग्लग्नमानेयम्, अस्तलग्नं तु षड्भयुक् ॥ ९९ ॥
व्यत्ययेनायनं कार्यं मेषादित्वप्रसिद्धये ॥ १००[a] ॥

तद्वा तत्फलयोर्योगाद्वपि च्छाया परा भवेत् ।
क्रान्त्यक्षयोश्च तत्कोट्योर्घाताद् भेदयुती[1] नरः ॥ ४६९ ॥

तद्वद् द्विरुदगन्यताप्यभावः कोणयोर्द्वयोः ।
अर्कघ्ने भाश्रुती शङ्कुभक्ते ते अङ्गुलात्मिके ॥ ४७० ॥

इति ॥

संस्कृतायनेति (95b-101)—

[लग्नानयने त्रैराशिकस्यायुक्तता]

प्राणानां राशिलिप्ताभिर्यादृशो नियमो भवेत् ।
तादृशो नियमो न स्यात् तद्भागावयवेष्वपि ॥ ४७१ ॥

अतस्त्रैराशिकं नात्र[2] कर्तव्यं लग्नसिद्धये ।
लग्नतो विपरीतत्वान्नाडिकाकरणेऽपि च ॥ ४७२ ॥

मूलम्— 1. C. शेषाः 2. B. शेषाः

व्याख्या—1. Mss. read भेदे युती 2. B. त्रैराशिकान्नात्र

[प्राग्लग्नस्य स्थूलता]

एकस्मिन्नपि राशौ तु क्रमात् कालो हि भिद्यते ॥ १००b ॥
तेन त्रैराशिकं नात्र कर्तुं युक्तं यतस्ततः ।
एवमानीतलग्नस्य स्थूलतैव न सूक्ष्मता ॥ १०१ ॥

[काललग्नम्]

सायनार्कभुजाप्राणाः प्राग्वत् स्वचरसंस्कृताः ।
काललग्नं तदेवाद्ये,[1] द्वितीये[2] तु तदूनितम् ॥ १०२ ॥
राशिषट्कं पदेऽन्यस्मिंस्तद्युतं चरमे पुनः ।
तदूनं मण्डलं लग्नकालः स्यादुदये रवेः ॥ १०३ ॥
द्युगतप्राणसंयुक्तः[3] कालो[4] विषुवदादिकः[5] ॥ १०४a ॥

सायनार्केति (102-6)—

[लग्नप्रवेशे भगोलसन्निवेशः]

क्रान्तिवृत्तक्षितिजयोः सम्पातद्वितयोद्गतम् ।
खमध्यस्पर्शि यद्वृत्ते दृक्क्षेपसममण्डलम् ॥ ४७३ ॥

पूर्वापरस्वस्तिकाभ्यां दृक्क्षेपसममण्डलम् ।
यावता चलितं तावद् याम्योदक्स्वस्तिकद्वयात् ॥ ४७४ ॥

क्षितिजस्थं नभोमध्यस्फुटं दृक्क्षेपमण्डलम् ।
तत्रस्यं क्रान्तिवृत्तस्य क्षितिजादन्तरं परम् ॥ ४७५ ॥

समवृत्ताच्च तत्रैव क्रान्तिवृत्तान्तरं परम् ।
वृत्तपातान्तरत्वेन समक्षितिजवृत्तयोः ॥ ४७६ ॥

मूलम्— 1. C. तदैवाद्ये   2. C_1 द्वितीयं
3. B. संयुक्त-   4. C. कालौ (C_1 काले)
5. A. दाधितः; C_1. दाधिकम्

[दृक्क्षेपः]

अन्त्यद्युज्याहतात्स्वाद् यत् त्रिज्याप्तं यश्च लम्बकः ॥ १०४b ॥

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काललग्नोत्थकोटिघ्नः करार्थाब्ध्युरगैर्हृतः ।
दृक्क्षेपस्तद्भिदैक्यं च काले कर्किमृगादिके ॥ १०५ ॥

अवयान्तरिते वेद्ये खमध्यक्षितिजे मिथः ।
राशिकूटद्वयक्रान्तिमण्डलाच्च तथाविधम् ॥ ४७७ ॥

दृक्क्षेपमण्डलगतं राशिकूटद्वयं च तत् ।
क्रान्तिमण्डलवृत्तार्धमध्यं तद्यावता मतम् ॥ ४७८ ॥

खमध्यात् क्षितिजात् तावद् भकूटं चान्यदुन्नतम् ।
समपार्श्वगतत्वेन राशिकूटायनान्तयोः ॥ ४७९ ॥

एकवृत्तगतैर्माध्यं मिथस्तुल्यान्तरैश्च तैः ।
याम्यसौम्यायनन्ताभ्यां सौम्ययाम्यभकूटयोः ॥ ४८० ॥

उन्मण्डलेन संयोगस्तुल्यकालस्ततो भवेत् ।
याम्यायनवशात् सौम्यराशिकूटोन्नतिस्ततः ॥ ४८१ ॥

सौम्यायनवशाद् राशिकूटं याम्यं तथोन्नतम् ।
क्षितिजाद् राशिकूटं तद् यावतैवोन्नतं भवेत् ॥ ४८२ ॥

सममण्डलतो दृक्क्षेपलग्नं तावदन्तरे ।
उन्नतिः सर्वदा तत्र सिद्ध्येत् तत्कालशङ्कुना ॥ ४८३ ॥

[दृक्क्षेपानयनवासना]

[श्लोकाः 104b-106a—]

उन्मण्डलाद् द्युवृत्तज्या लम्बकघ्ना त्रिजीवया ।
विहृता क्षितिजोन्मण्डलान्तरालान्वितोन्नतिः ॥ ४८४ ॥

सेष्टद्युज्याहृता[1] भूयः स्वद्युज्यापहृता[2] स्फुटा ।
राशिकूटे द्युवृत्तज्या[3] परमक्रान्तिसम्मिता ॥ ४८५ ॥

व्याख्या—1. B. सेष्टा द्युज्याहृता 2. B. ज्या विहृता
3. A. स्ववृत्तज्या

विश्लेषे लम्बजाधिक्ये सौम्यो याम्योऽन्यदा सदा ।
तत्त्रिज्याकृतिविश्लेषान्मूलं दृक्क्षेपकोटिका ॥ १०६ ॥

तद्व्यासार्धकृते वृत्ते भ्रामयत्येव तदन्वहम् ।
द्युज्यालम्बकघातघ्ना त्रिज्यावर्गोद्धृताऽथवा ॥ ४८६ ॥

भूयोऽन्त्यक्रान्तिनिहता स्वद्युज्याविहृता स्फुटा ।
काललग्नस्य कोटिज्या राशिकूटोन्नतिर्भवेत् ॥ ४८७ ॥

द्युज्यालम्बापक्रमास्तु[1] त्रय एते गुणा मताः ।
त्रिज्याद्वयमथ द्युज्या क्रमात् तेषां च हारकाः ॥ ४८८ ॥

गुणनं हरणं चात्र त्यज्यते द्युज्ययैकया ।
अन्त्यक्रान्त्या तु विहृतत्रिज्यावर्गोऽत्र हारकः[2] ॥ ४८९ ॥

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लम्बाहृतस्य स पुनः करार्थाब्ध्युरगैर्मितः ।
काललग्नस्य कोटिज्या द्युज्याघ्ना त्रिज्यया हृता ॥ ४९० ॥

उन्मण्डलादूर्ध्वंगता द्युवृत्तज्येऽति वर्णितम् ।
अयनान्तोन्नतिः काललग्नाद् राशित्रयोनितात् ॥ ४९१ ॥

मेषाद्यं काललग्नं तदयनान्तो मृगादिकः ।
काललग्नात् त्रिराश्यूनात् ततो ज्याग्रहणं मतम् ॥ ४९२ ॥

त्रिराश्यूनस्य दोर्ज्या या कोटिज्या या च ते समे ।
राशिकूटोन्नतिद्युज्या परमक्रान्तिसम्मिता ॥ ४९३ ॥

काललग्नोत्थकोटिज्यां ततोऽन्त्यक्रान्तिताडिताम् ।
त्रिज्यया विभजेदुन्मण्डलाल्लब्धा तदुन्नतिः ॥ ४९४ ॥

अत्रोन्मण्डलयाम्योदग्वृत्तसम्पातयोर्द्वयोः ।
ध्रुवौ द्वौ प्रवहाक्षिप्तावपि स्थैर्यं न मुञ्चतः ॥ ४९५ ॥

तयोः समतिरश्चीनः प्रवहोऽसौ परिभ्रमन् ।
भ्रामयेत् परितो बिम्बनेमिं केन्द्रं विना तयोः ॥ ४९६ ॥

व्याख्या—1. A. पक्रमाः स्युः 2. A. B. हारकाः

ततो ध्रुवयमनयोर्घटिकावृत्तपार्श्वयोः ।
निरक्षाद् घटिकावृत्तं समोपरिगतं भवेत् ॥ ४९७ ॥

निरक्षपार्श्वयोस्तस्माद् ध्रुवयोः स्थितिरिष्यते ।
निरस्तलक्षणं तस्माद् दृश्यत्वध्रुवयोर्द्वयोः ॥ ४९८ ॥

साक्षस्य लक्षणं साक्षतुल्यसौम्यध्रुवोन्नतिः ।
भगोलमध्यतः सौम्यध्रुवावधिकमार्गतः ॥ ४९९ ॥

अन्त्यक्रान्त्यन्तरे सौम्यं राशिकूटं सदा भवेत् ।
उन्मण्डलगतेः सौम्यायनादौ तद्गतं च तत् ॥ ५०० ॥

दक्षिणोत्तरवृत्तस्थे तद्वृत्तं चाधिरोहति ।
अयनान्तानुकारित्वं भकूटस्य स्थितं ततः ॥ ५०१ ॥

पलितत्वेन घटिकादक्षिणोत्तरवृत्तयोः ।
एकपार्श्वेन परमान्तरालस्थितवृत्ततः ॥ ५०२ ॥

भकूटवृत्तव्यासार्धमूलं सौम्यध्रुवात् ततः ।
भगोलमध्यसान्निध्यमन्त्यक्रान्त्युत्क्रमाद् भजेत् ॥ ५०३ ॥

तद्बाहुफलतुल्याया मूलं तद्वत् तदुन्नतेः ।
वेद्या समाद्य[1]ऊर्ध्वस्था निरक्षे सा तदुन्नतिः ॥ ५०४ ॥

साक्षे त्वक्षोत्क्रमेणापि ततोऽन्तर्गतिसम्भवात् ।
तिर्यग्भूतैव लम्बघ्ना त्रिज्याप्ता सा भवेद् ऋजुः ॥ ५०५ ॥

काललग्नस्य कोटिज्यां ततोऽन्त्यक्रान्तिताडिताम् ।
लम्बकेन पुनर्हत्वा त्रिज्यावर्गेण संहरेत् ॥ ५०६ ॥

यद्वा त्रिज्याकृतेरन्त्यक्रान्त्या लब्धेन संहरेत् ।
काललग्नस्य कोटिज्यां लम्बकघ्नां फलं क्यतः ॥ ५०७ ॥

याम्योदक्मण्डलेऽक्षज्या क्षितिजाद् या ध्रुवोन्नतिः ।
तया निरक्षक्षितिजराशिकूटद्युवृत्तयोः ॥ ५०८ ॥

व्याख्या—1. A. C. समाय

[दृक्क्षेपलग्नम्]

मध्याह्नाद्या नतप्राणा[1] निशीथाद्योन्नतासवः ।
एतद्बाणोनिता त्रिज्या चरज्याढ्या नता यदि ॥ १०७ ॥

उन्नताश्चेच्चरज्योना गोले याम्ये विपर्ययात् ।
द्युज्या लम्बकघातघ्ना त्रिज्याप्ता च पुनर्हृता ॥ १०८ ॥

सम्पातस्योन्नतिः शङ्कुश्चरांशस्य स नीयते ।
परमक्रान्तिकोटिघ्ना ततोऽक्षज्या विभाजिता ॥ ५०९ ॥

त्रिज्यया यत्र कर्तव्यं स्वर्णं पूर्वोदितं फलम् ।
इत्युपायान्तरेणापि दृक्क्षेपः साध्यते स्फुटः ॥ ५१० ॥

[श्लोकः 106b—]

[दृक्क्षेपकोटिः]

दृक्क्षेपवर्गहीनस्य त्रिज्यावर्गस्य यत्पदम् ।
ज्ञेया दृक्क्षेपकोटिः सा दृग्गतिज्या च सा मता ॥ ५११ ॥

मध्याह्नादिति (107-10)—

[उदयास्तलग्नवासना]

क्षितिजादुन्नतज्या हि द्युज्यालम्बवधाहृता ।
त्रिज्यावर्गोद्धृता शङ्कुरिष्टकालसमुद्भवः ॥ ५१२ ॥

स एवेष्टान्तरालं स्यात् क्षितिजक्रान्तिवृत्तयोः ।
दृक्क्षेपकोटिश्च तयोरन्तरालं परं भवेत् ॥ ५१३ ॥

त्रिज्यादृक्क्षेपकोटिभ्यां क्षितिजक्रान्तिवृत्तयोः ।
सिद्धयेदिष्टान्तरेणापि क्रान्तिवृत्तस्थदोर्गुणः ॥ ५१४ ॥

प्राग्लग्नं प्राक्कपाले स्यात् तद्धनुःसंयुतो रविः ।
अस्तलग्नं भवेत् पश्चात्कपाले तद्विवर्जितम् ॥ ५१५ ॥

शुद्धिक्षेपौ विपर्यस्तौ योजयेन्निशि लग्नयोः ।
द्युनिशोरुन्नतज्या च व्यत्ययात् कल्प्यते मिथः ॥ ५१६ ॥

मूलम्— 1. C_{10} मध्याह्नात् प्राङ्नतप्राणा

कोट्या दृक्क्षेपजीवाया लब्धचापं रवौ क्षिपेत् ।
तल्लग्नं प्राक्कपाले स्यान्निशि चेत् तद्विवर्जितम् ॥ १०६ ॥

प्रत्यग्गतेऽस्तलग्नं स्याद् व्यस्तमेव दिवानिशोः ।
प्राक्पश्चाल्लग्नयोर्मध्यं लग्नं दृक्क्षेपसंज्ञितम् ॥ ११० ॥

मध्याह्नतो नतासूनामुत्क्रमज्या विवर्जिता ।
उन्नतज्या भवेत् त्रिज्यागोलयोः सौम्ययाम्ययोः ॥ ५१७ ॥

चरज्यया च युक्तोना भवेद् दृश्यार्धसंस्थितेः[1] ।
अदृश्यार्धगते[2] कार्या चरज्या व्यत्ययात् ततः ॥ ५१८ ॥

उत्क्रमज्योन्नतासूनां यत्र प्राह्णार्धरात्रतः ।
तत्र तद्रहिता त्रिज्या नतज्या क्षितिजात् ततः ॥ ५१९ ॥

एवंसिद्धां नतज्यां वा क्षितिजादुन्नतां तु वा ।
द्युज्यालम्बकघातेन हत्वा त्रिज्याहृतां पुनः ॥ ५२० ॥

दृक्क्षेपकोट्या विभजेत् तयोर्घातेन वा हरेत् ।
लब्धचापं क्षिपेदर्के प्राग्लग्नं प्राक्कपालगम्[3] ॥ ५२१ ॥

तच्चापमर्कतस्त्याज्यं निशि प्राग्लग्नसिद्धये ।
प्रत्यक्कपालेऽस्तलग्नं तच्चापोनो दिवा रविः ।
प्रत्यक्कपालेऽस्तलग्नं तच्चापाढ्यो रविर्निशि ॥ ५२२ ॥

[दृक्क्षेपलग्नम्]

दृक्क्षेपलग्नं प्राक्पश्चाल्लग्नयोर्मध्यसंस्थितम् ।
ग्रहणावसरे चैतदर्कस्य वितनिष्यते ॥ ५२३ ॥

इति ॥

व्याख्या—1. B. संस्थिते 2. B. गते:

3. B. कपालकम्

[मध्यलग्नम्]

कालग्नं त्रिराश्यूनं मध्यकालस्ततः पुनः ।
लिप्ताप्राणान्तरं नीत्वा तद्दोश्चापे तु योजयेत् ॥ १११ ॥
ततश्चाद्यन् नयेत् प्राग्वत् तल्लिप्तान्तरमुद्धरेत् ।
कालदोर्धनुषि चेप्यं ततः प्राणकलान्तरम् ॥ ११२ ॥

काललग्नमिति (111-117)—

[भगोलावस्थितिमन्तरा मध्याह्नलग्नानयनवासना]

भ्राम्यति प्रत्यहं प्रत्यङ्मुखः प्रवहमारुतः ।
गोलाकारो घटीषष्ट्या निरक्षसमपश्चिमः ॥ ५२४ ॥

घटिकामण्डलं यस्य मध्येमार्गं प्रकल्प्यते ।
भ्राम्यतः पार्श्वयोर्यस्य स्थानाव[प्रच्युतौ][1] ध्रुवौ ॥ ५२५ ॥

घटिकामण्डलस्पृष्टं[2] द्वयोर्विषुवतोस्ततः[3] ।
अयनद्वितये[4] क्रान्त्या परयान्तरितं परम् ॥ ५२६ ॥

क्रान्तिवृत्तं स्वपार्श्वस्थराशिकूटद्वयं भवेत् ।
समपार्श्वस्थिते[5]र्वायुगोलतो ध्रुवयोर्द्वयोः ॥ ५२७ ॥

प्रवहप्रेरितर्क्षाणि परियन्ति ध्रुवद्वयम् ।
वायुगोलगतान्येव नक्षत्राण्यखिलान्यपि ॥ ५२८ ॥

व्याप्यते यैरिदं गोलसंस्थानैरखिलं नभः ।
वायुगोलगतं येन तं गृणन्ति भपञ्जरम्[6] ॥ ५२९ ॥

राशयः क्रमशः सूक्ष्माग्रस्पृक्कूटद्वयान्विताः ।
ज्योतिश्चक्राख्यतन्मध्यस्थितापक्रममण्डलाः ॥ ५३० ॥

राशिचक्रं यतः प्राहुस्तदपक्रममण्डलम् ।
राशीनामिह सर्वेषां यत्रास्ति युगपत्स्थितिः ॥ ५३१ ॥

व्याख्या—1. Mss. प्रत्युतौ 2. A. मण्डलं स्पृष्टं
3. A. विषुवतस्ततः 4. B. अयनं द्वितये
5. B. स्थितैः 6. A. भपञ्जराः

कालदोर्धनुषि क्षिप्त्वा तच्चापमविशेषयेत् ।
मध्यलग्नं तदेव स्यात् तत्काले प्रथमे पदे ॥ ११३ ॥

द्वितीयादिषु च प्राग्वन्मध्यलग्नमिहानयेत् ॥ ११४a ॥

[अविशेषं विना मध्यलग्नानयनम्]

[1]अविशेषं विना मध्यलग्नमानीयते यथा ॥ ११४b ॥

मध्यकालस्य कोटिज्या परमापक्रमाहता ।
त्रिज्यालब्धकृतिं त्यक्त्वा कालकोटित्रिजीवयोः ॥ ११५ ॥

राशीनां मध्यगामित्वाद् राशिचक्रं तदिष्यते ।
वायुगोलस्य कृत्स्नस्याप्यन्यथा तत्प्रसङ्गतः ॥ ५३२ ॥

यत्र क्वापि च दृष्टानि भानि मेषादिगान्यतः ।
घटिकावृत्तपार्श्वस्थध्रुवद्वितयतोऽन्वहम् ॥ ५३३ ॥

भ्राम्यतः प्रवहाक्षिप्ते राशिकूटे समन्ततः ।
चक्रपादान्तरितयोः क्रान्तिवृत्ताख्ययोः स्थितिः ॥ ५३४ ॥

घटिकावृत्ततो यद्वद् ध्रुवयोरुभयोः स्थितिः ।
ध्रुवौ प्रदक्षिणीकृत्य गतिः स्याद् राशिकूटयोः ॥ ५३५ ॥

प्रवहाक्षिप्तयोरन्त्यक्रान्तिव्यासार्धमण्डले ।
पार्श्वे तयोः क्रान्तिवृत्ता दृश्यादृश्यार्धमध्यगे ॥ ५३६ ॥

सम्पाताभ्यां च घटिकादक्षिणोत्तरवृत्तयोः ।
अधऊर्ध्वस्थितौ तौ च सम्पातौ स्तो निरक्षतः ॥ ५३७ ॥

उन्मण्डलावस्थितयोर्द्वयोर्विषुवतोः सतोः ।
दक्षिणोत्तरवृत्तस्थं राशिकूटद्वयं भवेत् ॥ ५३८ ॥

ततो विषुवतः क्रान्तिर्यावृक् सौम्या प्रवर्तते ।
दक्षिणोत्तरतस्तादृग् राशिकूटद्वयं व्रजेत् ॥ ५३९ ॥

मूलम्— 1. B. does not have the verses 114b-17.

वर्गाभ्यां शिष्टमूले द्वे कोटिज्या स्याद् द्विमौर्व्यपि ।
कोटिज्याद्युज्ययोर्घाताद् द्युज्यावाप्तं तु चापितम् ॥ ११६ ॥

विक्षेपद्वितयं प्रोक्तं राशिकूटद्वयोन्मुखम् ।
याम्यं भकूटं सौम्यान्त्यक्रान्त्यामुन्मण्डलाश्रितम् ॥ ५४० ॥

सौम्यं च याम्यान्त्यक्रान्त्यां तद्वदुन्मण्डलाश्रितम् ।
व्यस्तायनान्तानुसारि भकूटद्वितयं ततः ॥ ५४१ ॥

कोटिज्यायाः प्रवृत्तिश्च सर्वत्राप्ययनान्ततः ।
कोटिक्रान्त्या च तिर्यक्त्वं ध्रुवाभ्यां राशिकूटयोः ॥ ५४२ ॥

दक्षिणोत्तरवृत्तस्थे[1] सौम्ययाम्यायनद्वये ।
भकूटे याम्यसौम्ये द्वे तत्रैवोपर्यधोगते ॥ ५४३ ॥

उन्मण्डलस्थे तत्रैव प्राक्पश्चाद् भवति द्वयम् ।
अन्तरालेऽनुपातेन वेद्या तदनुसारिता ॥ ५४४ ॥

तिर्यग्वृत्तं ग्रहस्पृष्टं यद्भकूटद्वयोद्गतम्[2] ।
विषुवद्द्वितयस्पृष्टं वृत्तं चान्यद् ध्रुवोद्गतम् ॥ ५४५ ॥

तदन्तराले घटिकावृत्तज्या कालदोर्गुणः ।
तच्चापं कालदोःप्राणा घटिकावृत्तगामिनः ॥ ५४६ ॥

क्रान्तिक्षितिजसम्पातस्पृक् तिर्यग्वलनं हि तत् ।
उन्मण्डलघटीवृत्तपातस्पृग् यच्च मण्डलम् ॥ ५४७ ॥

तयोर्यद् घटिकावृत्ते विवरं तच्चरासवः ।
न्यूनास्तैः कालदोःप्राणा आद्यन्तपदयोरिह ॥ ५४८ ॥

अधिका मध्यपदयोस्तद्वशात् ते त्वृणं धनम् ।
दोःप्राणलिप्ताविवरमिष्टं प्राणकलान्तरम् ॥ ५४९ ॥

ग्रहात् प्राणस्ततः प्राणकलान्तरचरासुभिः ।
मध्यलग्नविधौ कार्यं परं प्राणकलान्तरम् ॥ ५५० ॥

व्याख्या—1. C. वृत्तस्थैः　　　　2. C. स्पृष्टं यत्कूटद्वयोद्गतम्

कालासवो मध्यलग्नभुजा तद्वीनभत्रयम् ।
पद्व्यवस्था सुगमैवाद्यमध्य[1]विलग्नवत् ॥ ११७ ॥

[॥ इति तन्त्रसंग्रहे छायाप्रकरणं नाम
तृतीयोऽध्यायः ॥]

कालग्नविधिः[1] कार्यो व्यस्तं तद्विशेषणात् ।
मध्यकालात् ततो मध्यलग्नं[2] प्राणकलान्तरात् ।
अविशिष्टाद् विपर्यस्तसंस्कृतात् स्फुटतामियात् ॥ ५५१ ॥

इत्येष परक्रोडावासद्विजवरसमीरितो योऽर्थः ।
इति तन्त्रसंग्रहस्य प्रोक्तोऽध्याये तृतीये सः ॥ ५५२ ॥

[इति तन्त्रसंग्रहस्य पद्यव्याख्यायां युक्तिदीपिकायां
छायाप्रकरणं नाम
तृतीयोऽध्यायः[3] ॥]

मूलम्— 1. C: सुगमैवान्यमध्य

व्याख्या—1. कालाल्लग्नविधिः 2. C. मध्ये लग्नं

3. A. C. No colophon, B. इति तन्त्रसंग्रहव्याख्याने तृतीयोऽध्यायः ।

अथ चतुर्थोऽध्यायः

चन्द्रग्रहणप्रकरणम्

[चन्द्रग्रहणे योगकालः]

अर्कस्फुटं सचक्रार्धं भूच्छायास्फुटमुच्यते ।
सूर्यास्तमयकालोत्थौ छायाचन्द्रौ समीपगौ ॥ १ ॥

उदये वाथ विन्यस्य तद्योगोऽत्र निरूप्यताम् ।
चन्द्रेऽधिके गतो योगो, न्यूने चैष्य इति स्थितिः ॥ २ ॥

तदन्तरं तु षष्टिघ्नं गत्यन्तरहृतं तयोः ।
योगकालो घटीपूर्वो गतो गम्योऽपि वा क्रमात् ॥ ३ ॥

[मङ्गलाचरणम्]

बालव्युत्पत्तिफलो वाक्प्रसरो यत्प्रसादतो विदुषाम् ।
बालेन्दुलसन्मौलिं वाग्देवीं तां नमस्यामि ॥ १ ॥

दिक्कालौ भाभ्रमविधिं दशप्रश्नोत्तरं तथा ।
दर्शयित्वाथ सूर्येन्द्वोर्वक्ष्यते ग्रहणद्वयम् ॥ २ ॥

[योगकालवासना]

अर्कस्फुटमिति (1-3)—

भूच्छाया छादयेच्चन्द्रं चक्रार्धान्तरितार्कतः ।
पक्षान्तेऽथ विधुः सूर्यं मासान्ते ग्रहणद्वये ॥ ३ ॥

यदार्कास्तमयासन्नं ग्रहणं शीतदीधितेः ।
तदार्कास्तमये कार्यौ चन्द्रार्कावुदयेऽन्यथा ॥ ४ ॥

चन्द्रेऽधिके विप्रकर्ष उपर्युपरि वर्धते ।
अर्केऽधिके सन्निकर्षः क्रमेण स्यात् तयोर्द्वयोः ॥ ५ ॥

[रवीन्द्वोः पर्वान्तकालस्फुटः]

तात्कालिकौ पुनर्नीत्वा मध्यार्केन्दुस्फुटावपि ।
उदयाद्योगकालेन नीयेते[1] चेत् तदुक्तवत् ॥ ४ ॥
तात्कालिकार्कनिष्पन्नचरसंस्कार इष्यते ।
अस्तकालोक्तवत् तस्मात् चाल्येते[2] चेत् चरोद्भवः ॥ ५ ॥
इष्टकालार्कतश्चैवं कार्यः[3] प्राणकलान्तरात् ।
दोर्भेदाच्चापि संस्कारो रवीन्दू तौ स्फुटौ तदा ॥ ६ ॥

गत्यन्तरेण च तयोर्योग ऊर्ध्वसमोऽपि वा ।
दिनगत्यन्तरेणात्र षष्टिर्नाड्यो भवन्ति हि ॥ ६ ॥

इष्टगत्यन्तरात् कालः कल्प्यस्तन्नियमात् ततः ।
गम्यस्त्वर्केऽधिके योगकालश्चन्द्रेऽधिके गतः ॥ ७ ॥

तात्कालिकाविति (4-8a)—

[ग्रहणे स्फुटसूक्ष्मताया आवश्यकता]

प्रतिक्षणं प्रभिन्नैव स्फुटभुक्तिर्ग्रहचारिणाम् ।
कालभुक्त्योर्मिथस्तस्मान्नानुपातः प्रवर्तते ॥ ८ ॥

क्षणान्तरेषु तद्भुक्तेर्भिन्नरूपतया स्थितेः ।
कालभुक्त्योरेकरूपसम्बन्धानुपपत्तितः ॥ ९ ॥

अदूरवर्तिनं कालमुद्दिश्यारोपिते सति ।
नियमे कालतद्भुक्त्योरनुपातः प्रवर्तते ॥ १० ॥

तदर्थं स्फुटतोऽर्केन्द्वोर्योगकाले निरूपिते ।
कालान्तरे मुहुर्मध्यस्फुटकालादि नीयते ॥ ११ ॥

इति ।

[रवीन्द्वोरविशिष्टस्फुटः]

तथा—

अर्केन्द्वन्तरलिप्ताभ्यो गत्यन्तरकलाहृतः[1] ।
योगकालो स्फुटे भुक्तेर्भिन्नत्वात् प्रतिनाडिकम् ॥ १२ ॥

मूलम्— 1. C. नीयते 2. C. चाल्यते 3. C. कार्यं

व्याख्या—1. C. हृतम्

योगकालस्ततो नेयस्तन्निघ्ना स्वा स्फुटा गतिः ।
षष्ट्याप्ता स्वस्फुटे योज्या गम्ये योगेऽन्यथान्यथा ॥ ७ ॥
समलिप्तौ भवेतां तौ पर्वान्तसमयोद्भवौ ॥ ८a ॥

[रवीन्द्वोः कक्ष्याव्यासार्धयोजनम्]

दशाभ्यस्ता त्रिजीवेन्दोः[1] कक्ष्याव्यासार्धयोजनम् ॥ ८b ॥
तच्चन्द्रभगणाभ्यस्तं भानोः स्वभगणोद्धृतम् ॥ ९a ॥

प्रसिद्धः प्रत्यहं भेदः स्फुटभुक्तेर्ग्रहचारिणाम् ।
दिनांशेष्वपि[1] तद्भेदः किन्न स्यान्नाडिकादिषु ॥ १३ ॥

ततस्त्रैराशिकानीतः कालोऽसौ न स्फुटो भवेत् ।
कालान्मध्यौ स्फुटौ ताभ्यां कालं चेन्द्वर्कयोर्नयेत् ।
ततोऽन्यो[2] न्यायतस्तस्य स्फुटत्वादविशेषतः ॥ १४ ॥

इति ॥

[कक्ष्याव्यासार्धयोजनवासना]

दशाभ्यस्तेति (8b-9a)—

दशयोजनविस्तीर्णा यत्र स्वप्रमिताः कलाः ।
भ्राम्यति प्रत्यहं भुक्त्या स्वयेन्दुस्तत्र मण्डले ॥ १५ ॥

भगोलमध्याद् यत्केन्द्रमुपर्यन्त्यफलान्निजात् ।
ततस्तद्भगणाभ्यस्ताद् भानुः स्वभगणोद्धृते ॥ १६ ॥

इन्दोर्युगकला यस्मात् खकक्ष्या स्याद् दशाहता ।
खकक्ष्यायोजनगतिर्युगेनैकेन च ग्रहः ॥ १७ ॥

तत्कक्ष्या च भकक्ष्यातो भवेत् स्वभगणोद्धृता ।
कक्ष्याणां महदल्पत्वे भगणाल्पमहत्त्वतः ॥ १८ ॥

मूलम्— 1. C. त्रिजीवेन्द्वोः
व्याख्या—1. A. दिनाङ्केष्वपि　　　2. A. ततोन्या

[भू-रवि-शशीनां बिम्बयोजनव्यासाः]

भूवृत्तादुदितात् प्राग्वद् व्यासस्तस्यापि[1] नीयताम् ॥ ९b ॥

4410 315

दिग्वेदाब्धिमितो भानोर्व्यासस्तिथ्यग्नयो विधोः ॥ १०a ॥

[रविशशिनोः स्फुटयोजनकर्णः]

कालकर्णहतं[2] स्वस्वकक्ष्याव्यासार्धयोजनम् ॥ १०b ॥

त्रिज्याप्तं स्याद् भगोलस्य मण्डलस्य च मध्ययोः ।

योजनैरन्तरालं स्यात् तत्तत्कालोद्भवं स्फुटम् ॥ ११ ॥

खकक्ष्यातो दिनगतिर्ग्रहाणां भुविनोद्धृता ।

योजनैरेकरूपत्वं तद्गतेर्भूविनैक्यतः ॥ १९ ॥

स्ववृत्तोच्चावचत्वेन तेषां भेदः कलागतेः ।

कर्णोऽपि तेषां वृत्तानां व्यासार्धं योजनात्मकम् ॥ २० ॥

तत्सिद्धभगणाभ्यस्तं साध्यस्य भगणोद्धृतम् ।

भगणाल्पतया तेषां कर्णगौरवदर्शनात् ॥ २१ ॥

इति ।

[भूरविशशीनां बिम्बयोजनव्यासाः]

भूवृत्तादिति (9b-10a)—

3300

[1]उक्तः प्रागेव परिधिः खखदेवमितो भुवः ।

113 355

त्रीशघ्नपरिधेस्तस्माद् व्यासोऽर्येष्वग्निभिर्हृतः ।

अर्केन्द्वोर्बिम्बयोर्योजनव्यासाविह कीर्तितौ ॥ २२ ॥

[रविशशिनोः स्फुटयोजनकर्णवासना]

कलाकर्णहतमिति (10b-11)—

स्थितिर्यादृङ्नियमतस्त्रिजीवामन्दकर्णयोः ।

तादृशो नियमो मध्यस्फुटयोजनकर्णयोः ॥ २३ ॥

मूलम्— 1. C. तत्रापि 2. C. हृतं

व्याख्या—1. C. omits this line and the next line.

[रवीन्द्वोः द्वितीयस्फुटयोजनकर्णः]

उच्चोनशशिकोटिज्यादलं पर्वान्तजं स्फुटम् ।
[1]स्फुटयोजनकर्णे स्वं जह्यात् कर्क्यादिजं ततः ॥ १२ ॥
[2]स्वभूम्यन्तरकर्णः स्यात् तेन बिम्बकलां नयेत्[3] ।
स्फुटयोजनकर्णे स्वे मासान्ते शशिवद् रवेः ॥ १३ ॥
व्यस्तं पश्चान्तजं कार्यं रविभूम्यन्तराप्तये ॥ १४a ॥

मध्ययोजनकर्णोऽतो मन्दकर्णकलाहत: ।
स्फुटयोजनकर्ण: स्यात् सूर्येन्द्वोस्त्रिज्यया हृत: ॥ २४ ॥

उच्चोनेति (12-14a)—

[भगोले अर्केन्दूच्चानामवस्थितिः गतिप्रकारश्च]

इन्दूच्चोनार्ककोटिज्यादलतुल्यैश्च योजनैः ।
भुवोऽर्कतमसोर्मार्गे भूगोलो यात्युपर्यधः ॥ २५ ॥

अतस्तदेवान्त्यफलं गृह्यते योजनात्मकम् ।
इन्दूच्चोनार्ककोटिज्यादलेनोपरि गच्छति ॥ २६ ॥

भूगोलतो भगोलोऽयमुच्चात् तत्सप्तमावधः ।
अर्कोनचन्द्रयोःकोट्योज्यार्द्धयेऽन्त्यफलाहते ॥ २७ ॥

त्रिज्याहृते फले स्यातां द्वोःकोट्योर्योजनात्मके ।
अर्कोनेन्दुतदुच्चोनार्कायनैक्यभिदावशात् ॥ २८ ॥

स्फुटयोजनकर्णे स्वे धनर्णं कोटिजं तयोः ।
इन्दूच्चसन्निकृष्टेऽर्के याते तत्सन्निधिं विधौ ॥ २९ ॥

भूगोलतो विप्रकृष्टः स्याद् भगोलगतो विधुः ।
तद्बिन्दूच्चतो विप्रकृष्टेर्केऽर्काच्च शीतगौ ॥ ३० ॥

प्राग्वद्भूगोलो भूगोलाद् विप्रकृष्टो भवेद् ध्रुवम् ।
इन्दूच्चसन्निकृष्टेऽर्के ततो दूरस्थिते विधौ ॥ ३१ ॥

मूलम्— 1. B. स्फुटे 2. C. स॰ (wr.)
3. B. कला नयेत्

[अर्कन्द्वोर्बिम्बकलाव्यासः]

बिम्बस्य योजनव्यासं[1] विष्कम्भार्धहतं हरेत् ॥ १४b ॥

इन्दूच्चविप्रकृष्टेऽर्के याते चन्द्रेऽर्कसन्निधिम् ।
इन्द्वाश्रितो भगोलोऽयमध एव व्रजेद् भुवः ॥ ३२ ॥

तद् भगोलगतिः कल्प्या चन्द्रोच्चवदुपर्यधः ।
चन्द्रोच्चार्कतदिन्दूनां विवरद्वितयायनात् ॥ ३३ ॥

[द्वितीयस्फुटयोजनकर्णवासना]

कोटीफलधनर्णत्वं तुल्यं, तुल्यात् ततः कृतम् ।
स्फुटयोजनकर्णे स्वे तत्स्वदोःफलवर्गयोः ॥ ३४ ॥

योगतो ग्रहभूबिम्बघनमध्यान्तरं पदम् ।
त्रिज्याघ्नतद्दोःफलतस्तेन कर्णेन यद्धृतम् ॥ ३५ ॥

कर्क्यादि स्वे विधूच्चोनरवौ सति धनात्मकम् ।
ऋणं मृगादिगे चार्कोनेन्दौ मेषादिसंस्थिते ॥ ३६ ॥

व्यत्ययेन तुलादिस्थे द्वितीयस्फुटकर्म तत् ।
द्वितीयस्फुटसिद्धश्च ग्राह्यो दृग्विषये विधुः ॥ ३७ ॥

स्पष्टीकरिष्यते चैतदूर्ध्वं शृङ्गोन्नतौ विधोः[1] ।
कोटीफलस्य पूर्णत्वात् पक्षमासान्तयोरिह ॥ ३८ ॥

तदेव केवलं शोध्यं स्फुटयोजनकर्णतः ।
उच्चेनेन्दौ मृगादिस्थे कर्क्यादौ त्यज्यते च तत् ॥ ३९ ॥

चन्द्रेऽर्कसन्निकृष्टेऽसौ विधिर्दूरगतेऽन्यथा ।
कर्णयोर्वैपरीत्येन पक्षमासान्तयोर्मिथः ।
दोःफलाभावतस्तत्र भवेत् तस्यैव कर्णता ॥ ४० ॥

बिम्बस्य योजनव्यासमिति (14b-17a)—

[रवीन्दुबिम्बकलाव्यासवासना]

बिम्बान्यर्केन्दुतमसां विप्रकर्षक्रमाद् भुवः ।
कृशतामुपगच्छन्ति वर्धन्ते सन्निकर्षतः ॥ ४१ ॥

मूलम्— 1. C. योजनं व्यासं

व्याख्या—1. This refers to ch. VIII of the work.

स्वभूम्यन्तरकर्णेन लिप्ताव्यासः शशीनयोः ॥ १५[a] ॥

[भूच्छायाबिम्बकलाव्यासः]

1050 3360
रविभूम्यन्तरं खेषु[1]पङ्क्तिघ्नं, खर्तुनिर्जरैः ॥ १५[b] ॥
हृतं, भूगोलविष्कम्भाद् भूच्छायादैर्घ्ययोजनम् ।
चन्द्रभूम्यन्तरं त्यक्त्वा शेषे भूव्यासताडिते ॥ १६ ॥
छायादैर्घ्यहृते व्यासः, चन्द्रवत् तमसः कलाः ॥ १७[a] ॥

स्वभूम्यन्तरकर्णानां ह्रासवृद्धिवशात् ततः ।
बिम्बानां ह्रासवृद्धिभ्यां व्यस्तत्रैराशिकं भवेत् ॥ ४२ ॥

त्रिज्यातुल्यकलाव्याप्तैः स्वभूम्यन्तरयोजनैः ।
उद्धृताः स्युः कलाव्यासा बिम्बानां योजनात्मना ॥ ४३ ॥

मानद्वयेन मेयत्वं यत्रैकस्यैव वस्तुनः ।
मानतन्मेययोस्तत्र वृद्धिह्रासौ विपर्ययात् ॥ ४४ ॥

व्यस्तत्रैराशिकेनैव तत्रास्तत्फलोन्मयः ।
एकोऽत्र योजनव्यासः स्वकर्णह्रासवृद्धितः ॥ ४५ ॥

महदल्पत्ववैचित्र्यात्मानारूपः[1] कलात्मकः ।
त्रिज्यैवैका भगोलस्य व्यासार्धं स्यात् कलात्मकम् ॥ ४६ ॥

स्फुटयोजनकर्णस्य [उभे][2] सत्यप्युपर्यधः ।
बिम्बव्यासस्ततस्त्रिज्यानिहतो योजनात्मकः[3] ॥ ४७ ॥

स्वभूम्यन्तरकर्णेन हृतेऽर्केन्द्वोः कलात्मकः ।
इत्थं योजनकर्णाप्ते त्रिज्यया निहते सति ॥ ४८ ॥

त्रैराशिकेन लिप्तात्वं[4] बिम्बानां योजनात्मनाम् ।
व्यस्तत्रैराशिकं चास्य[5] वशादत्र यदन्तरा[6] ॥ ४९ ॥

मूलम्— 1. C. स्वेषु (wr.)

व्याख्या—1. C. रूपा 2. C. Mss. read only भे
3. C. योजनात्मकम् 4. A. लिप्तत्वं
5. A. काञ्चस्य; B. काञ्जस्य 6. A. यदुत्तरा

[चन्द्रविक्षेपः स्फुटभुक्तिश्च]

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पातोनेन्दोर्भुजाजीवा व्योमताराहता, हृता ॥ १७b ॥

स्फुटयोजनकर्णेन हरणं गुणनं तथा ।
कलामेयात् तदुभयमाचार्येण न दर्शितम् ॥ ५० ॥

[भूच्छायाकलाव्यासवासना]

ज्योतिर्गोलो महाव्यासो, भासयत्यखिलं रविः ।
आत्माभिमुखम्, अन्यार्धे च्छायां कुर्वन् क्रमात् कृशाम् ॥ ५१ ॥

अतोऽर्काभिमुखं दीप्तं भूम्यर्धं मलिनं[1] परम् ।
छाया च तस्या भूव्याससमादौ क्रमशः कृशा ॥ ५२ ॥

रवियोजनकर्णघ्नाद् भूव्यासाव्यासयोस्तयोः[2] ।
अन्तरेण विभज्याप्तं भूच्छायादैर्घ्यमिष्यते ॥ ५३ ॥

समन्ततोऽर्कबिम्बस्य व्यासाग्रात् प्रसृताः क्रमात् ।
यत्रातिलङ्घ्य भूव्यासं संगच्छन्तेऽन्यपार्श्वगाः ॥ ५४ ॥

भूच्छाया तत्र विज्ञेया मूले भूव्याससम्मिता ।
दीर्घवृत्ता कृशाग्रा च चक्रार्धान्तरिता रवेः ॥ ५५ ॥

रविभूव्यासविवरेणार्ककर्णो भवेद् यदि ।
भूव्यासेन [कियान्][3] रश्मिसन्निकर्षो रवेर्भवेत् ॥ ५६ ॥

इति त्रैराशिकात् छायादैर्घ्यं भूगोलतो भवेत् ।
तद्व्यासस्य भवेदग्रान्मूले भूव्याससम्मितः ॥ ५७ ॥

चन्द्रभूम्यन्तरोनस्य तस्य व्यासोऽत्र नीयताम् ।
छायाव्यासश्चन्द्रमार्गे[4] ततः स्याद् योजनात्मकः ॥ ५८ ॥

कक्ष्यैक्याद्विन्दुतमसोर्ग्राह्यग्राहकयोरिह ।
चन्द्रभूम्यन्तरं बिम्बलिप्तानां हारको द्वयोः ॥ ५९ ॥

पातोनेन्दोरिति (17b-19a)—

[चन्द्रविक्षेपानयनवासना]

विक्षिप्ते मन्दवृत्तार्धे स्वपातात् सौम्ययाम्ययोः ।
[5]तद्वशाद् ग्रहवृत्तं च तन्नेमिस्थोच्चकेन्द्रकम् ॥ ६० ॥

व्याख्या—1. A. भूम्यर्धमखिलं 2. C. स्ततः 3. Mss. क्रियां
4. A. C. व्यासश्च भूमार्गे 5. A. C. defective : द्वे शाद्ग्रहवृत्तं

त्रिज्यया, सौम्ययाम्येन्दोः क्षिप्तिः, सा च स्फुटा गतिः ।
भगोलचन्द्रकर्णघ्ने भूचन्द्रान्तरयोजनैः ॥ १८ ॥

हृते, स्फुटे इह ग्राह्ये क्षिप्तिभुक्ती स्थितेर्दले ॥ १९[a] ॥

[ग्रहणस्य सदसद्भावः]

क्षिप्तिः सा चन्द्रभूच्छायाबिम्बैक्यार्धाधिका यदि ॥ १९[b] ॥

स्ववृत्तपरिधौ यत्र भवेन्मन्दस्फुटो ग्रहः ।
मन्दकर्णस्तदवधिर्मन्दनीचोच्चकेन्द्रतः ॥ ६१ ।

ऊनाधिकोऽसौ त्रिज्यातो ग्रहवृत्तकलामितः[1] ।
तद्व्यासार्धं च यद्वृत्तं कर्णवृत्तं तदिष्यते ॥ ६२ ॥

तत्कालप्रमितो मान्दः कर्णस्त्रिज्यासमस्तदा[2] ।
ग्रहाणां पठितः क्षेपो मन्दकर्णकलामितः ॥ ६३ ॥

पातोनमन्दस्फुटतो दोर्ज्यान्त्यक्षेपताडिता ।
त्रिज्यया ह्रियते तस्मात् क्षेपाप्त्यै क्षेपशालिनाम् ॥ ६४ ॥

पठितो ग्रहवृत्ते चेत् क्षेपोऽसौ त्रिज्यया हतः ।
ह्रियेत मन्दकर्णेन शोध्यः पातश्च मध्यमात् ॥ ६५ ॥

पातोन[3]स्फुटतस्तस्माद् दोर्गुणात् क्षेपताडितात् ।
त्रिज्याप्तोऽसौ स्फुटः सूर्यसिद्धान्तवचनं यथा ॥ ६६ ॥

स पुनर्मन्दकर्णेन निहतो योजनात्मना ।
[4]द्वितीयस्फुटकर्णेन विहृतो दृग्विधौ स्फुटः ।
स्फुटभुक्तिस्तथानीतैर्वार्केन्द्वोर्दृग्विधौ स्फुटा ॥ ६७ ॥

[चन्द्रग्रहणसम्भववासना]

क्षिप्तिः सेति (19b-21a)—

चन्द्रभूच्छाययोरेककलावस्थितयोरपि ।
सौम्ययाम्यात्मकात् क्षेपाद् ग्रहणं प्रतिबध्यते ॥ ६८ ॥

व्याख्या—1. A. मिता 2. B. समस्तथा
3. A. B. पातेन 4. A. द्वितीये

ग्रहणं नैव चन्द्रस्य, हीना चेदस्य सम्भवः ॥ २०a ॥

[समस्तग्रहणम्]

चन्द्रबिम्बोनभूच्छाया बिम्बार्धादधिका यदि ॥ २०b ॥

सर्वग्रासो न चैव स्याद्, हीना चेद् ग्रस्यतेऽखिलम् ॥ २१a ॥

[स्थित्यर्धं स्पर्शमोक्षौ च]

सम्पर्कार्धकृतेस्त्यक्त्वा क्षेपवर्गं पदीकृतम् ॥ २१b ॥

भूच्छाया कान्तिवृत्तस्था विक्षिप्तश्चन्द्रमास्ततः ।
विक्षेपश्चन्द्रतमसोर्बिम्बकेन्द्रान्तरं मतम् ॥ ६९ ॥

विक्षेपश्चन्द्रभूच्छायाबिम्बार्धैक्यसमो यदा ।
तद्बिम्बनेम्योः संस्पर्शाविव स्यात् तत्र न ग्रहः ॥ ७० ॥

[समस्तग्रहणवासना]

[श्लोकः २०b-२१a]

गृह्यते तमसा चन्द्रः क्षेपो न्यूनस्ततो यदि ।
चन्द्रबिम्बोनभूच्छायाबिम्बार्धादल्पके सति ॥ ७१ ॥

क्षेपे समस्तग्रहणमिन्दोः स्यादधिके पुनः ।
क्षेपाधिक्यवशादिन्दोर्बिम्बभागस्य दृश्यता ॥ ७२ ॥

यावद् ग्राहकबिम्बार्धं ग्राह्यबिम्बार्धतोऽधिकम् ।
तत्तुल्ये स्फुटविक्षेपे न्यूने वा निखिलग्रहः ॥ ७३ ॥

ग्राह्यार्धरहितग्राहकार्धतो यावताधिकः ।
क्षेपस्तत्सदृशो ग्राह्यबिम्बभागो बहिर्गतः ॥ ७४ ॥

ग्राह्यग्राहकयोगार्धात् क्षेपो न्यूनश्च यावता ।
तत्तुल्यो ग्राह्यबिम्बांशो ग्राहकान्तर्गतो भवेत् ॥ ७५ ॥

ग्राह्यग्राहकयोर्बिम्बघनमध्यान्तरं हि सः ।
ग्रासमानं ततः सम्पर्कार्धतः क्षेपवर्जितात् ॥ ७६ ॥

[चन्द्रग्रहणे स्थित्यर्धस्पर्शमोक्षवासना]

सम्पर्कार्धकृतेरिति (21b-27)—

कृत्स्नैकदेशसदसद्ग्राह्यादिग्रहणस्य यः ।
स तु क्षेपवशात् सौम्ययाम्याद् बिम्बान्तराग्मतः ॥ ७७ ॥

षष्टिघ्नं भानुशीतांश्वोर्हृतं गत्यन्तरेण यत् ।
स्थित्यर्धनाडिकाद्यं तत्, पर्वान्ते तद्युतोनिते ॥ २२ ॥
मोक्षः स्पर्शश्च चन्द्रस्याप्यविशिष्टौ[1] स्फुटौ तु तौ ॥ २३[a] ॥

[स्थित्यर्ध-स्पर्श-मोक्षाणाम् अविशेषः]

स्थित्यर्धघ्ने स्फुटे भुक्ती[2] षष्ट्याप्ते भानुचन्द्रयोः ॥ २३[b] ॥
शोधयेत् समलिप्तेन्दौ[3] सूर्याच्च स्पार्शिकावुभौ ।
स्वभुक्तिमन्यथा पाते सदा तात्कालिकीकृतौ ॥ २४ ॥

स्पर्शमोक्षौ तयोर्बिम्बान्तरात् प्रागपरात् तथा ।
स्पर्शमोक्षान्तरालं च स्थित्यर्धद्वयसम्मितम् ॥ ७८ ॥

स्पर्शमध्यग्रहणयोः स्पर्शस्थित्यर्धमन्तरम् ।
मोक्षमध्यग्रहणयोर्मोक्षस्थित्यर्धसंज्ञितम् ॥ ७९ ॥

स्वस्वविक्षेपतश्चैतद् भिन्नरूपद्वयं मिथः ।
[1]समन्ताविष्टविक्षेपान्तरितं क्रान्तिमण्डलात् ॥ ८० ॥

विक्षेपकोटिवृत्तं तन्नानारूपं प्रतिक्षणम् ।
क्षेपो भिन्नो भवेत् स्पर्शमध्यमोक्षेषु शीतगोः ॥ ८१ ॥

विक्षेपकोटिवृत्तेन सदा भ्राम्यति चन्द्रमाः ।
स्पर्शमोक्षान्तरं मध्याद् बिम्बैक्यार्धसमं द्वयोः ॥ ८२ ॥

क्रान्तिवृत्तेऽथ तत्क्षेपवर्गभेदपदं तु यत् ।
विक्षेपकोटिवृत्तोत्थं स्थित्यर्धक्षेत्रमिष्यते ॥ ८३ ॥

एकमार्गगतानां तु योगो गत्यन्तराद् भवेत् ।
विनगत्यन्तरेणात्र षष्टिर्नाड्यो भवन्ति चेत् ॥ ८४ ॥

स्थित्यर्धक्षेत्रतुल्येन कियान् कालो भवेत् ततः ।
स्थित्यर्धमेवमानीतं भवति स्पर्शमोक्षयोः ॥ ८५ ॥

मूलम्—1. C. शिष्टौ तु तौ स्फुटौ　　2. C. (except 8) भुक्ति
3. C. समलिप्तेन्दोः

व्याख्या—1. A. समन्तादिष्ट ; B. सतादिष्ट

स्पर्शेन्दोश्च पुनः क्षेपस्थित्यर्धं तद्गतिः[1] शशी ।
प्राग्वदेवासकृत् कार्यो निश्चलत्वदिदृक्षुणा ॥ २५ ॥
[2]स्थित्यर्धगतिमर्केन्द्वोः क्षिप्त्वा तौ मौक्षिकौ नयेत् ।
अन्यत् सर्वं समं मोक्षे स्थित्यर्धस्याविशेषणे ॥ २६ ॥

[स्पर्श-मोक्ष-स्थित्यर्धानाम् अविशेषकर्मवासना]

[श्लोका: 23b-26—]

तद्वूने मध्यकालेऽस्य स्पर्शो मोक्षोऽथ तद्युते ।
स्यादेतद् यदि विक्षेपौ तुल्यौ स्यातां द्वयोर्मिथः ॥ ८६ ॥

स्थित्यर्धद्वितयं भिन्नं क्षेपे भिन्ने भवेत् ततः ।
ततो विशेषविधिना स्थित्यर्धद्वयमानयेत् ॥ ८७ ॥

तदा तन्मध्यविक्षेपबिम्बयोगार्धयोर्द्वयोः ।
वर्गान्तरपदं षष्ट्या हृत्वा गत्यन्तरोद्धृतम् ॥ ८८ ॥

स्थित्यर्धं मध्यपर्वान्तात् त्यजेत् तत्रापि शीतगुम् ।
पातं सषड्भमर्कं[1] च नीत्वा विक्षेपमानयेत् ॥ ८९ ॥

बिम्बयोगार्धतश्चास्मात् क्षेपात् स्थित्यर्धमानयेत् ।
स्थित्यर्धं बिम्बयोगार्धतस्तत्क्षेपसमागतम् ॥ ९० ॥

आद्यतो मध्यपर्वान्तात् त्यजेदेव मुहुर्मुहुः ।
अविशिष्टे पुनस्तस्मात् स्पर्शकालं समाविशेत् ॥ ९१ ॥

प्रक्षिपेन्मध्यपर्वान्ते स्थित्यर्धं प्राक्तनं क्षिपेत् ।
नीत्वार्केन्दू तथा पातं तत्र विक्षेपमानयेत् ॥ ९२ ॥

स्थित्यर्धं च ततः क्षेपात् बिम्बयोगार्धतो नयेत् ।
आद्ये तु मध्यपर्वान्ते स्थित्यर्धं प्रक्षिपेदपि ॥ ९३ ॥

मूलम्—1. A गतः ; C. (edn.) गती 2. A. स्थित्यर्धे

व्याख्या—1. A. B. पातं षष्ड्भमर्कं

[स्थित्यर्धाभ्यां स्पर्शमोक्षौ]

स्पर्शस्थितिदलं शोध्यं पर्वान्तादितरत् क्षिपेत् ।
स्पर्शमोक्षौ तु तौ स्यातां मध्ये स्यात् परमो ग्रहः[1] ॥ २७ ॥

अर्केन्दुपातांस्तत्रापि नीत्वा क्षेपं तथैव च ।
स्थित्यर्धं मध्यपर्वान्ते त्याद्य एव क्षिपेन्मुहुः ॥ ९४ ॥

तावत्कुर्यादिदं यावत् स्थित्यर्धस्याविशिष्टता ।
स्थित्यर्धेनाविशिष्टेन युक्तेऽस्मिन् मोक्षमादिशेत् ।. ९५ ॥

[स्थित्यर्धाभ्यां स्पर्शमोक्षानयनवासना]

[श्लोकः 27—]

मध्यग्रहश्चलेत् स्थित्यर्धेऽधिके स्पर्शमोक्षयोः ।
अन्त्यविक्षेपकोटिघ्नात् पातोनार्कस्य दोर्गुणात् ॥ ९६ ॥

इष्टविक्षेपकोट्याप्ता क्षेपकोटिगुणो भवेत् ।
अन्त्यद्युज्याहता दोर्ज्या यथेष्टद्युज्यया हृता ॥ ९७ ॥

इष्टविक्षेपकोट्याश्च तस्याः क्षेपस्य तस्य च ।
वर्गयोगपदं यत् स्याच्चापितं यच्च दोर्धनुः ॥ ९८ ॥

पातोनार्कस्य विश्लेषं तयोः षष्ठ्या निहत्य तु ।
गत्यन्तरेण विभजेदर्केन्द्वोर्नाडिकादिकम् ॥ ९९ ॥

प्रक्षिपेत् पूर्वपर्वान्ते विक्षेपे युक्पदस्थिते ।
त्यजेदोजपदस्थेऽस्मिन् पर्वान्तः सुस्फुटो यतः ॥ १०० ॥

क्षेप ओजपदस्थश्चेदुपर्युपरि वर्धते ।
क्षीयते युक्पदगते क्षेत्रं स्थित्यर्धसम्भवम् ॥ १०१ ॥

पर्वान्तः प्रचलेत् स्थित्यर्धेऽधिके पूर्वपर्वतः ।
एवंकृतो हि पर्वान्तः सूर्येन्द्वोर्ग्रहणे स्फुटः ॥ १०२ ॥

मूलम्—1. C. परमग्रहः

[रव्युदयास्तमये स्पर्शमोक्षयोः दृश्यादृश्यत्वम्]

उदयास्तमयासन्ने स्पर्शे मोक्षे च संशयः ।
स्पर्शो दृश्य उतादृश्यश्चन्द्रस्यास्तमये त्विति ॥ २८ ॥

प्राग्वा पश्चाच्च मोक्षः स्यात् तत्प्रदेशोदयादिति ॥ २९[a] ॥

[स्पर्शमोक्षयोः दृश्यादृश्यत्वनिर्णयवासना]

उदयास्तमयासन्ने इति (28-36) —

खमध्यतस्तमोबिम्बघनमध्यस्थनेमिकम् ।
वृत्तं यत्तत् तमोबिम्बदृङ्मण्डलमुदीरितम् ॥ १०३ ॥

ततो दृङ्मण्डलात् क्रान्तिवृत्तस्य विवरं हि यत् ।
अधोभागे तमोबिम्बनेम्यां तत् परिकल्पयेत् ॥ १०४ ॥

तमोबिम्बे परिणतः स दृक्क्षेपोऽभिधीयते ।
तद्विष्टक्षेपयोर्योगे विश्लेषो वा यथोचितम् ॥ १०५ ॥

तावदन्तरिते दृङ्मण्डलाद्विन्दुस्तमो व्रजेत् ।
तदन्तरं तमोबिम्बगतं दोर्ज्या प्रकल्प्यते ॥ १०६ ॥

तत् तमोव्यासदलयोः कोटिर्वर्गान्तरात् पदम् ।
दोर्ज्यामूलात् तमोबिम्बघममध्यान्तरं च सा ॥ १०७ ॥

तत्कोटिलम्बनयुतेस्तमश्शङ्कुर्यदा समः ।
तदेन्दोर्ग्रहणे स्पर्शमोक्षौ लक्ष्यौ न चान्यथा ॥ १०८ ॥

तमोबिम्बे चन्द्रबिम्बस्पर्शमोक्षौ तदैव हि ।
भूपृष्ठसमपार्श्वस्थौ नान्यथा व्यवधानतः ॥ १०९ ॥

वलनक्षेपसद्भावे त्वेवं दृश्यत्वकल्पना ।
विक्षेपवलनाभावे तौ दृङ्मण्डलमूलगौ ॥ ११० ॥

तदा लम्बनसंयुक्ततमोव्यासार्धसम्मिते ।
दृश्याविन्दौ स्पर्शमोक्षौ न तु न्यूने कथञ्चन ॥ १११ ॥

[स्पर्शमोक्षयोः दृश्यादृश्यत्वनिर्णयः]

स्पर्शे रव्युदये कार्यो दृक्क्षेपः क्षिप्तिरैन्दवी ॥ २९b ॥

व्यासार्धघ्नः स्फुटः क्षेपः[1] सम्पर्कार्धहृतस्तु यः ।
[2]तद्दृक्क्षेपधनुर्भेदो दिशोः साम्येऽन्यथा युतिः ॥ ३० ॥

तदूनभत्रयाज्जीवा तमोव्यासदलाहृता ।
त्रिज्याप्ता लम्बने योज्या भूच्छायाशङ्कुलब्धये ॥ ३१ ॥

द्वितीयस्फुटभागस्य[3] तिथ्यंशो लम्बनं त्विह ।
राशित्रयाधिके क्षेपदृक्क्षेपानीतकार्मुके ॥ ३२ ॥

वलनक्षेपबाहुल्याद् यदा तद्योगसम्भवः[1] ।
वलनं स्यात् तमोबिम्बपादतोऽभ्यधिकं भवेत् ॥ ११२ ॥

पार्श्वप्रवेशात् तमसः स्पर्शमोक्षौ तदोपरि ।
ततस्तत्कोटिरहिते शङ्कौ दृश्यौ तु तावुभौ ॥ ११३ ॥

भूपृष्ठसमपार्श्वस्थे तत्प्रवेशे तथाविधे ।
तदा तमोबिम्बघनमध्ये भूपृष्ठपार्श्वतः ।। ११४ ॥

तत्कोट्याधःस्थिते स्पर्शमोक्षौ दृश्यौ नभस्तले ।
तदप्रकोट्या रहितं लम्बनं शङ्कुरिष्यते ।
शङ्कुसिद्धैर्नतप्राणैस्तद्दृश्यादृश्यकल्पना ॥ ११५ ॥

इति ॥

[स्पर्शमोक्षयोर्दृश्यादृश्यत्वनिर्णयवासना]

[श्लोकाः २९-३६]—

ग्राह्यग्राहकयोश्चन्द्रतमसोरर्कचन्द्रयोः ।
बिम्बयोरन्तरं सम्पर्कार्धं स्यात् स्पर्शमोक्षयोः ॥ ११६ ॥

मूलम्—1. A. स्फुटं क्षेपः ; C. स्फुटक्षेपः
2. A. तं दृक्क्षेप ; C. तद्दृक्क्षेपाद्　　3. C. भागस्या (wr.)

व्याख्या—1. A. B. सम्भवात्

अधिकस्य गुणात् प्राग्वत् लब्धं शोध्यं तु लम्बनात् ।
शेषस्तस्य तमःशङ्कुस्त्रिज्याकृत्या [1]हतः स च ॥ ३३ ॥

हृतो[2] घातेन सूर्यस्य द्युज्याया लम्बकस्य च ।
लब्धाः प्राणाः क्षपाशेषे यदि रव्युदयात् ततः[3] ॥ ३४ ॥

बिम्बयोर्नेमिमात्रेण संस्पर्शः स्यात् तयोर्यतः ।
बिम्बयोर्घनमध्ये तद्व्यासार्धान्तरिते द्वयोः ॥ ११७ ॥

सम्पर्कार्धं ततो बिम्बान्तरं स्यात् स्पर्शमोक्षयोः ।
क्रान्तिवृत्तगतावर्कात् क्षिप्तः स्वक्षेपतो विधुः ॥ ११८ ॥

सम्पर्कार्धगते[1] वृत्ते क्षेपो तत्स्पर्शमोक्षयोः ।
कल्प्यते तद्वशाद् यत्र घनमध्यान्तरं द्वयोः ॥ ११९ ॥

सम्पर्कार्धकृते वृत्ते क्षेपो तत्स्पर्शमोक्षयोः ।
त्रिज्याहताच्च सम्पर्कार्धाप्तस्तद्वृत्तगः स च ॥ १२० ॥

दृक्क्षेपस्त्विष्टकालोत्थस्त्रिज्यावृत्तगतः स्वतः ।
तुल्यातुल्यदिशोर्योगा[2]न्तरोत्थं वलनं तयोः ॥ १२१ ॥

तदेव वलनं तत्र तमोबिम्बे प्रकल्पयेत् ।
तत्रैव चन्द्रबिम्बस्य सम्भवात् स्पर्शमोक्षयोः ॥ १२२ ॥

क्षेपदृक्क्षेपयोर्भिन्नतुल्ययोर्भेदयोगतः ।
तमोबिम्बे परिणतं वलनं स्पर्शमोक्षयोः ॥ १२३ ॥

तत्कोटिस्ततमोव्यासवलवर्गान्तरात् पदम् ।
त्रिज्या वा क्षेपदृक्क्षेपयोगभेदशरोनिता ॥ १२४ ॥

बिम्बव्यासार्धनिहता तमसस्त्रिज्यया हृता ।
क्षेपदृक्क्षेपचापैक्यस्यौजयुग्मपदक्रमात् ॥ १२५ ॥

मूलम्—1. A. B. हृतः (wr.) 2. A. हृतो (wr.)
3. B. Hapl. om. of ततः to ततः next line.

व्याख्या—1. A. सम्पकार्धकृते 2. C. दिशा योग

स्पर्शः प्रागेव, तत्रैव दृश्यः स्यान्न ततः परम्[1] ।
एवं रव्यस्तकालोत्थक्षेपाद्याप्तेन शङ्कुना ॥ ३५ ॥
सिद्धैः प्राणैर्यदा मोक्षो रव्यस्तमयतः परम् ।
तदैव दृश्यतामेति ततः प्राङ्मोक्षणेन च ॥ ३६ ॥

इन्द्वोर्लम्बनलिप्तासु क्षिपेदथ विशोधयेत् ।
द्वितीयस्फुटभोगस्य प्रायः पञ्चदशांशकः ॥ १२६ ॥

उदयास्तमयासन्ने चन्द्रलम्बनलिप्तिकाः ।
त्रिनपञ्चदशांशोऽपि यत्र लम्बननाडिकाः ॥ १२७ ॥

तदेतद् ग्रहणेऽर्कस्य पश्चात् स्पष्टीकरिष्यते[1] ।
तासां लम्बनलिप्तानां शङ्कुत्वे परिकल्पिते ॥ १२८ ॥

पूर्ववद् गतगन्तव्याः प्राणाः कार्याश्च तद्यथा ।
त्रिज्यावर्गहृताच्छङ्कोर्[2]द्युज्यालम्बवधोद्धृताः ॥ १२९ ॥

चापिता गतगम्यास्ते पूर्वापरकपालयोः ।
मोक्षे स्पर्शे च तत्तुल्यैः प्राणैर्यद्वा ततोऽधिकैः ॥ १३० ॥

गतगम्यैर्निशायां तद्दृश्यत्वं नान्यथा द्वयोः ।
भूपृष्ठपार्श्वादूर्ध्वस्थौ स्पर्शमोक्षौ यदा विधोः । १३१ ॥

तदैव दृश्यौ नान्यत्र भूपृष्ठव्यवधानतः ।
भूपृष्ठपार्श्वं भूमध्यपार्श्वादूर्ध्वगतं सदा ॥ १३२ ॥

निजलम्बनलिप्ताभिर्भिन्नाभिः स्वस्वकक्ष्यया[3] ।
तदन्तरस्थितं सर्वं दृश्यार्धेऽपि न दृश्यते ॥ १३३ ॥

यद्भूपृष्ठव्यवहितं यात्यदृश्यार्धशेषताम् ।
भगोलमध्यान्मन्दान्त्यफलान्ते कृतकेन्द्रकम् ॥ १३४ ॥

मूलम्—1. B. Hapl. om. after परं to परं, next line.

व्याख्या—1. The allusion is to ch. V. सूर्यग्रहणप्रकरणम् ।

2. A. त्रिज्यावर्गोद्धृतशङ्कोः   3. A. C. भिन्नाभिन्नस्वकक्ष्यया

भ्राम्यतः प्राङ्मुखं पुष्पवन्तौ वृत्ते निजेऽन्वहम् ।
भुक्तिः प्रतिदिनं तुल्या निजवृत्तगतानयोः ॥ १३५ ॥

भगोलप्रमिता भुक्तिर्भिन्ना प्रागेव दर्शिता ।
भगोलमध्यग्रहयोर्मन्दकर्णोऽन्तरं भवेत् ॥ १३६ ॥

स्ववृत्तप्रमितश्चासौ त्रिज्यातुल्या भवेदसौ ।
ग्रहवृत्तमितस्त्रिज्यातोऽधिकोनो भवेदपि ॥ १३७ ॥

बिम्बभुक्त्योः कर्णवृत्तकलाभिरनुमेयता ।
स्फुटयोजनकर्णाप्ते [1]यतस्त्रिज्याहते स्फुटे ॥ १३८ ॥

स्यादेतद् यदि कल्प्येते भगोले चेदुभे अपि ।
ततो न्यूनाधिके स्यातां भगोलविषये उभे ॥ १३९ ॥

भगोलमध्यं भूगोलाद् यातीन्दूच्चादुपर्यधः ।
मन्दकर्णस्य तेनापि स्यातां वृद्धिक्षयौ ततः ॥ १४० ॥

द्वितीयस्फुटकर्मापि ततो दृग्विषये भवेत् ।
उपर्यधश्च भूगोलाद् भगोलेऽस्मिश्चलत्यपि ॥ १४१ ॥

वायुगोलस्य भूगोलं परितः स्थितिरिष्यते ।
भूगोलस्यानुहरते वायुगोलः सदाप्यधः[2] ॥ १४२ ॥

अन्यथा वायुगोलोऽयं भूगोलं भ्रामयेदपि ।
यतो रथ्यादिवत् सोऽपि कुर्यादेवोदयादिकम् ॥ १४३ ॥

येनैकस्मिन् दिनेऽर्कस्य दृश्यादृश्यार्धयोः स्थितिः ।
भगोलेनोपपद्येत युगपत्परिकल्पनात् ॥ १४४ ॥

वायुगोलस्य मध्यस्थो भूगोलः कल्प्यते ततः ।
भगोलस्त्वर्कतमसोः सूत्रेणोपर्यधो व्रजेत् ॥ १४५ ॥

इन्दूच्चदिशि भूगोलाद् यत्र भ्राम्यन्त्यमी ग्रहाः ।
भूगोलमध्यकेन्द्रत्वे वायुगोलस्य निश्चिते ॥ १४६ ॥

व्याख्या—1. C. यत्र त्रिज्या 2. B. सदा-gap-धः

इन्दूच्चोनार्ककोटिज्याबलतुल्यैश्च योजनैः ।
भगोलमध्यं भूगोलमध्यात् गच्छत्युपर्यधः ॥ १४७ ॥

भ्राम्यते वायुगोलेन तदाक्रान्ततया मुहुः ।
ततस्तदाश्रितानां च द्युवृत्तानि द्युचारिणाम् ॥ १४८ ॥

वायुगोलानुसारेण कुर्वतामुदयादिकम् ।
विप्रकर्षवशाद् भूमेर्विविधानि स्युरन्वहम् ॥ १४९ ॥

द्वितीयस्फुटकर्णस्य यद् व्यासार्धत्वमिष्यते ।
व्यासार्धं सर्ववृत्तानां त्रिज्या स्यात्[1] स्वकलामिता ॥ १५० ॥

तयोः सम्बन्धनियमात् त्रिज्यायोजनकर्णयोः ।
लिप्तास्त्रैराशिकात् साध्या बिम्बादेर्योजनात्मता[2] ॥ १५१ ॥

तद्वद् दृग्विषये साध्या भुक्तिलिप्ताः स्वयोजनैः ।
भुक्तिरम्बरकक्ष्यातो भूदिनैर्योजनात्मिका ॥ १५२ ॥

भगोलस्यानुहरते विक्षेपः[3] पठितो बुधैः ।
कर्णवृत्तमितत्वेन तद्वद् वृद्धिक्षयान्वितः ॥ १५३ ॥

त्रिज्या भगोलव्यासार्धं सर्वदा स्वकलामितम् ।
क्षेपस्तत्प्रमित[4]स्तद्वत् सर्वदा स्वकलासमः ॥ १५४ ॥

अन्त्यक्षेपहृता दोर्ज्या त्रिज्ययैव विभज्यते ।
न पुनर्मन्दकर्णेन पातोनस्फुटचन्द्रतः ॥ १५५ ॥

प्रतिमण्डललिप्ताभिर्मन्दकर्णः प्रमीयते ।
क्षेपो भगोलप्रमितस्त्रिज्याव्यासदलो हि सः ॥ १५६ ॥

भगोलविषयस्त्वेवं विक्षेपः परिकल्प्यते ।
स्फुटयोजनकर्णघ्नात् क्षेपात् तस्मात् समुद्धृतः ॥ १५७ ॥

द्वितीयस्फुटकर्णेन क्षेपो ग्राह्यो विधोर्ग्रहे ।
भगोलविषयादेव चन्द्रात् पातो विशोध्यताम् ॥ १५८ ॥

व्याख्या—1. A. has an extra सा here. 2. A. B. C. योजनात्मना
3. A. B. विक्षेपैः 4. A. प्रमितं

क्षेपस्यैव विभिन्नत्वाद् भगोलेन[1] विधोरपि ।
भगोलस्थं हि सर्वत्र पातेन्द्वन्तरमिष्यते ।। १५९ ।।

स्फुटेन्दोः केवलादेव ततः पातविशोधनम् ।
अत एवोक्तममुना स्वयं प्रकरणान्तरे ।। १६० ।।

"द्वितीयस्फुटतः पूर्वं विक्षेपो नीयतां विधोः ।
अपक्रमं पुनः कुर्याद् द्वितीयस्फुटितेन्दुतः" ।। १६१ ।।

इति स्फुटेन्दुतस्तस्मात् केवलात् पातशोधनम् ।
न तु स्फुटीकृताविष्टं द्वितीयस्फुटकर्णता ।। १६२ ।।

स्फुटयोजनकर्णघ्ना भगोलविषया गतिः ।
द्वितीयस्फुटकर्णेन हृता दृग्विषये गतिः ।। १६३ ।।

मण्डलार्धान्तरितयोर्मिथोऽपक्रममण्डले ।
भ्राम्यतोरर्कतमसोः पार्श्वेनेन्दुः परिभ्रमन् ।। १६४ ।।

इष्टक्षेपान्तरे क्रान्तिवृत्तात् तत्कोटिमण्डले ।
पक्षमासान्तयोस्ताभ्यां युञ्जानोऽपि मुहुर्मुहुः ।। १६५ ।।

क्षेपाल्पत्वाद् यदा पातासत्त्या बिम्बं तयोर्विशेत् ।
रवेर्बिम्बप्रवेशेन ग्रहणं तस्य जायते ।। १६६ ।।

छन्नत्वाद् रविबिम्बस्य तत्रेन्दोस्तमसि स्थितेः ।
पश्चाद्गतं शीघ्रगतिः पुरोगं मन्दगामिनम् ।। १६७ ।।

आक्रामत्येकमार्गस्थः पृष्ठस्थं भिन्नमार्गगः ।
युगपत् प्राङ्मुखौ प्रत्यङ्मुखावप्येकदिङ्मुखौ ।। १६८ ।।

प्रत्यङ्मुखं च भ्रमणं ग्रहाणां वक्रगामिनाम् ।
भ्रमणं प्राङ्मुखं नित्यमुभयोरर्कचन्द्रयोः ।। १६९ ।।

ताराग्रहाणां चान्येषां सर्वदा क्रमचारिणाम् ।
द्वयोर्गत्यन्तराद् यत्र योगकालो निरूप्यते ।। १७० ।।

व्याख्या—1. C. भूगोलेन

गत्या शीघ्रगतस्तत्र मन्दं गच्छति रिक्तया[1] ।
आसत्त्या ग्रहयोर्भाव्यं भेदाभावस्ततोऽन्यथा ॥ १७१ ॥

आसत्तिर्गतियोगेन भिन्नदिङ्मुखयोर्द्वयोः ।
यत्रासन्नौ क्रमात् स्यातां गतियोगेन तावुभौ ॥ १७२ ॥

अतोऽत्र गत्योर्योगेन योगकालो निरूप्यते ।
एकदिङ्मुखता यस्मादुभयोरर्कचन्द्रयोः ॥ १७३ ॥

ततो गत्यन्तरेणैव पर्वान्तो नीयते तयोः ।
शीघ्रभुक्तिर्यदा मन्दभुक्तेर्याति पुरस्सरा[2] ॥ १७४ ॥

विप्रकर्षात् क्रमाद्योगस्तयोर्नोपरि विद्यते ।
अत एव तयोर्योगस्तत्रातीतः प्रकल्पितः ॥ १७५ ॥

मन्दभुक्तिर्यदा शीघ्रभुक्तेर्याति पुरस्सरा[3] ।
सन्निकर्षक्रमात् तत्र भावी योगस्तयोर्मतः ॥ १७६ ॥

योगे भाविनि पर्वान्तकालः प्रतिपदोऽन्यथा ।
तत्कालानीतभागेन स्यातां तौ समलिप्तकौ[4] ॥ १७७ ॥

एकमार्गस्थयोस्तत्र तयोर्योगो भवेद् ध्रुवम् ।
क्षेपे सति तु तत्कोटिमार्गेणेन्दुः परिभ्रमन् ॥ १७८ ॥

ग्राह्यग्राहकयोः क्षेपे बिम्बयोगार्धतोऽल्पके ।
ग्राह्यग्राहकयोरर्कतमसोर्बिम्बमाविशन् ॥ १७९ ॥

विक्षेपकोटिवृत्तस्थग्भागान्मुक्तस्ततोऽपि सन् ।
सम्पर्कार्धेऽपि विक्षेपकोटया कुर्यात् स्थितेर्दलम् ॥ १८० ॥

अतोऽत्र क्षेपवर्गोनसम्पर्कार्धकृतेः पदात् ।
षष्टिघ्नादर्कशीतांशोर्गत्यन्तरकलोद्धृतम् ॥ १८१ ॥

स्थित्यर्धं नाडिकाद्यं तदुभयोः स्पर्शमोक्षयोः ।
स्वेष्टविक्षेपजनितं भिन्नत्वं स्यात् तयोर्मिथः ॥ १८२ ॥

व्याख्या—1. C. गम्यनिरिक्तया 2. A. C. परस्परम् ; B. पुरस्सरः
3. B. C. पुरस्सरः 4. A. B. लिप्तिकौ

[स्पर्शमोक्षेष्टग्रासाः मध्यग्रहणं च]

यद्वा तत्कालसूर्येन्दुस्फुटपातादिकं नयेत् ।
तत्रेन्दुधरणिच्छायास्फुटान्तरकला हृताः ॥ ३७ ॥

स्थित्यर्धात् स्वात् भवेत् क्षेपः स्थित्यर्धं क्षेपतः स्वतः ।
अन्योन्यायत्तसिद्धित्वात् स्थित्यर्धक्षेपयोर्द्वयोः ॥ १८३ ॥

स्थित्यर्धयोर्विभिन्नत्वात् क्षेपात् स्यात् स्पर्शमोक्षयोः ।
स्थित्यर्धहीनसंयुक्तः पर्वान्तस्पर्शमोक्षयोः ॥ १८४ ॥

तत्कालेन्दुं च तत्क्षेपं तत्रत्यं किं न भेदयेत् ।
अत एवाविशेषोऽत्र कार्यः स्थित्यर्धयोर्द्वयोः ॥ १८५ ॥

स्थित्यर्धेनाविशिष्टेन पर्वान्तो हि न संयुतः ।
पृथगेको द्वयोः कालं विदध्यात् स्पर्शमोक्षयोः ॥ १८६ ॥

मध्यकालोऽपि तन्मध्याच्चलेत् स्थितिदलेऽधिके ।
तदीयं चलनं चात्र सम्यग् युक्त्या निदर्शितम् ॥ १८७ ॥

यद्वेति (37-43)—

[इष्टग्रासानयनवासना]

ग्राह्यग्राहकयोः क्षेपे बिम्बयोगार्धतोऽल्पके ।
उक्तो ग्रहणसद्भावस्तदभावस्ततोऽधिके । १८८ ॥

मध्यग्रहणतः स्पर्शमोक्षौ स्थित्यर्धतो निजात् ।
बिम्बान्तरेण सूक्ष्मेण तत्परिच्छिद्यतेऽखिलम् ॥ १८९ ॥

ततो बिम्बान्तरं नेयमिष्टकालोद्भवं स्फुटम् ।
सम्पर्कार्धाद् विशुद्धेऽस्मिन्निष्टग्रासो भवेद् यतः ॥ १९० ॥

ग्राह्यो क्रमोत्क्रमज्ये द्वे ग्राह्यग्राहकभेदतः ।
क्रमज्यावर्गतः क्षेपवर्गयुक्तात् तयोरथ ॥ १९१ ॥

उत्क्रमज्यान्तरकृतिं युक्त्वा मूलीकृतं तु यत् ।
बिम्बान्तरं सुसूक्ष्मं स्याद् ग्राह्यग्राहकयोर्द्वयोः ॥ १९२ ॥

द्वितीयगतिभेदेन पूर्वमुक्त्यन्तरोद्धृता ।
स्फुटान्तरमिह ग्राह्यं तस्य विप्तेश्च वर्गयोः ॥ ३८ ॥

योगे तच्छरभेदस्य वर्गं युक्त्वा पदीकृते ।
बिम्बान्तरं सुसूक्ष्मं स्यादिष्टग्रासे तथैव च ॥ ३९ ॥

स्फुटान्तरस्य वर्गात् तु कृत्स्नव्यासहृतः[1] शरः ।
क्षेपस्याप्येवमेव स्यात् स्वेषुवर्गयुतान्मुहुः ॥ ४० ॥

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[1]सूक्ष्मं बिम्बान्तरं कर्तुं गृह्येते ज्याशरौ यतः ।
द्वितीयगतिभेदघ्नं पूर्वगत्यन्तरोद्धृतम् ॥ १९३ ॥

तत्र स्फुटान्तरं ग्राह्यं चन्द्रभूच्छाययोर्द्वयोः ।
सूक्ष्मं बिम्बान्तरं कर्तुं गृह्येते ज्याशरौ यतः ॥ १९४ ॥

नन्वत्रानीयते बाणः कथङ्कारं स्फुटान्तरात् ।
समस्तज्याकृतेर्बाणः कृत्स्नव्यासोद्धृतो यतः ॥ १९५ ॥

सत्यं किन्त्विह कृत्स्नज्या प्रायः स्वधनुषा समा ।
ग्राह्यग्राहकयोर्भेदलिप्तानां स्वल्पतावशात् ॥ १९६ ॥

पातोनेन्दोर्भवेत् क्षेपस्तदर्धज्यात्मको मतः ।
ततस्तद्वर्गतः कृत्स्नव्यासाप्तो दुष्करः शरः ॥ १९७ ॥

कृत्स्नज्यावर्गतस्तु स्यादर्धज्यावर्गतस्तु चेत् ।
कृत्स्नज्यातो भवेद् बाणः कृत्स्नज्या सा च बाणतः ॥ १९८ ॥

इत्यन्योन्याश्रयत्वेन स्फुटो बाणोऽविशेषतः ।
अर्धज्यावर्गतो लब्धबाणवर्गयुतान्मुहुः ॥ १९९ ॥

समस्तज्यात्वमानीतात् कृत्स्नव्यासोद्धृतः शरः ।
त्र्यंशो बाणकृतेर्यद्वा कृत्स्नज्याचापवर्गयोः ॥ २०० ॥

मूलम्— 1. A. व्यासोद्धृतः

व्याख्या—1. C. om. this line.

इष्टवर्गत्रिभागोनचापवर्गात् तथापि वा ।
सम्पर्कार्धाद् विशुद्धेऽस्मिन् ग्रासो बिम्बान्तरे सदा ॥ ४१ ॥

[ग्रहणस्य अदृश्यत्वावस्थितिः]

स्वच्छत्वात् षोडशांशोऽपि ग्रस्तश्चन्द्रो न दृश्यते ।
लिप्तात्रयमपि ग्रस्तं तीक्ष्णत्वान्न विवस्वतः ॥ ४२ ॥

अन्तरं स्यात् ततो [1]बाणवर्गत्र्यंशविवर्जितात् ।
चापवर्गात् स्वकृत्स्नज्यावर्गतुल्यात् तदुत्क्रमः ॥ २०१ ॥

कृत्स्नज्यासोद्धृतो बाणः समस्तज्याकृतेर्युतः[2] ।
किन्तु बाणः स कृत्स्नज्यायत्तः सापि स्वबाणतः ॥ २०२ ॥

इत्यन्योन्याश्रयत्वं तद् अविशेषान्निरस्यते ।
तदर्थं प्रथमं चापवर्गाद् बाणं समानयेत् ॥ २०३ ॥

तत्कृतेस्त्र्यंशहीनाच्च कृत्स्नज्यां चापवर्गतः ।
अर्धज्यावर्गतः कर्णकोटीयोगहृतः शरः ॥ २०४ ॥

इत्यर्धज्याकृतेर्बाणं कृत्स्नज्यां वा ततो नयेत् ।
स्फुटान्तरक्रमज्या वा विक्षेपस्य च वर्गयोः ॥ २०५ ॥

योगे तच्छरयोर्भेदवर्गं युक्त्वा पदीकृतम्[3] ।
बिम्बान्तरं सुसूक्ष्मं स्याद् इष्टग्रासेऽर्कचन्द्रयोः॥ २०६ ॥

तदूनाद् बिम्बयोगार्धादिष्टग्रासोऽवशिष्यते ।
तादृग्बिम्बान्तरे बिम्बयोगार्धेन समे सति ॥ २०७ ॥

स्पर्शमोक्षौ स्फुटौ बिम्बनेम्योः संस्पर्शमात्रतः ।
बिम्बान्तरे स्वल्पतमे परमग्राससम्भवः ॥ २०८ ॥

[परमग्रासस्य स्फुटपर्वान्ताच्चलनं ग्रहणादेश्यानादेश्यता च]

[श्लोकौ 42-43]—

स्थित्यर्धयोर्द्वयोः सोऽयमधिको दृश्यते क्वचित् ।
प्रसिद्धात् स्फुटपर्वान्ताच्चलनं सम्भवेद् यतः ॥ २०९ ॥

व्याख्या—1. C. Hapl. om. after बाण to बाण, two lines below.

2. A.B. कृते युतः ; C. कृते सति 3. C. पदीकृते

[परमग्रासस्य स्फुटपर्वान्ततश्चलनम्]

अल्पश्चेत् परमग्रासश्चलेत् स्थितिदलेऽधिके ।
तस्माद् बिम्बान्तरेणैव ग्रासोऽन्वेष्यो महानिह ॥ ४३ ॥

[अक्षवलनं अयनवलनं च]

नतज्याक्षज्ययोर्घातस्त्रिज्याप्तस्तस्य[1] कार्मुकम् ।
तदंशाः सौम्ययाम्यास्ते पूर्वापरकपालयोः ॥ ४४ ॥

ग्रहणं वाच्यमादेश्यानादेश्याविविभागतः ।
अन्यथा निर्विशन् लोके हास्य एव भवेद् ध्रुवम् ॥ २१० ॥

[वलनस्वरूपम्]

नतज्याक्षज्ययोरिति (44-46a)—

भ्राम्यन्ति क्रान्तिवृत्तेन स्वगत्या प्राङ्मुखं ग्रहाः ।
प्रत्यङ्मुखं च प्रवहाक्षिप्ता यान्ति ध्रुवृत्ततः ॥ २११ ॥

निरक्षसमपूर्वापराधऊर्ध्वदिगाश्रितम् ।
घटिकामण्डलं तत्तु ध्रुवृत्तं विषुवद्द्वये ॥ २१२ ॥

विषुवद्द्वितयस्पृष्टं तन्मध्ये तस्य पार्श्वयोः ।
अन्त्यक्रान्त्यन्तरे चान्यत् तत्तुल्यं क्रान्तिमण्डलम् । २१३ ॥

घटिकामण्डलः स्पष्टस्तत्र स्याद् विषुवद्द्वयम् ।
विप्रकृष्टं परक्रान्त्या द्वयोरप्ययनान्तयोः ॥ २१४ ॥

पार्श्वद्वयावगाहित्वात् तत्स्फुटत्वाच्च तत्समम् ।
क्रान्तिवृत्तं तु तद्यत्र भ्राम्यन्ति प्राङ्मुखं ग्रहाः ॥ २१५ ॥

यद्यपि क्रान्तिवृत्तेन भ्राम्यन्ति प्राङ्मुखंगताः ।
तथापि प्रवहाक्षिप्ता यान्ति प्रत्यङ्मुखाः सदा ॥ २१६ ॥

मूलम्—1. C. घातत्रिज्याप्तं तस्य

राशित्रययुताद् ग्राह्यात् क्रान्त्यंशैर्दिक्समैर्युतात् ।
भेदेऽन्तराद् गुणस्तेन हृत्वा बिम्बान्तरं हरेत् ॥ ४५ ॥

त्रिज्यया वलनं स्पष्टं वृत्ते बिम्बान्तरोद्भवे ॥ ४६[a] ॥

प्रत्यग्भ्रमानुसारेण भवेत् तेषां द्युमण्डलम् ।
प्रत्यहं भिन्नरूपं तद् घटिकावृत्तपार्श्वगम् ॥ २१७ ॥

समपूर्वापरविशोर्मिरक्षे क्षितिजाश्रितम् ।
घटिकामण्डलं याम्ये खमध्याद् वलतेऽक्षतः ॥ २१८ ॥

तत्पार्श्वस्थद्युवृत्तानि तद्वत् साक्षे बहून्यपि ।
तद्गतानां ग्रहर्क्षाणां प्रतीचां प्रवहभ्रमात् ॥ २१९ ॥

बिम्बपूर्वापरार्धे द्वे वलिते सौम्ययाम्ययोः ।
प्राक्कपाले, ततः प्रत्यक्कपाले तु विपर्ययात् ॥ २२० ॥

[अक्षवलनम्]

तथात्वाद् वृत्तपादस्य पूर्वापरकपालयोः ।
तदक्षायत्तसिद्धित्वादाक्षं वलनमुच्यते ॥ २२१ ॥

खमध्यतो नतांशज्या त्रिज्यातुल्या यदा भवेत् ।
तदा स्वाक्षज्यया तुल्यमाक्षं वलनमिष्यते ॥ २२२ ॥

नतज्यया ग्राह्यबिम्बघनमध्यावधेस्ततः ।
आक्षं वलनमुद्दिष्टं सम्बन्धनियमात् ततः ॥ २२३ ॥

[अयनवलनम्]

अयनान्तोत्थिता दोर्ज्या त्रिज्यातुल्या यदा भवेत् ।
तदान्त्यक्रान्तितुल्यं तदायनं वलनं भवेत् ॥ २२४ ॥

गच्छतां क्रान्तिवृत्तेन तद्वद् वलनसम्भवात् ।
अयनान्ताद् ग्राह्यबिम्बघनमध्यावधेस्ततः ॥ २२५ ॥

दोर्ज्यायाः परमक्रान्तिहतायास्त्रिज्ययोद्धृतम् ।
आयनं वलनं ज्ञेयमयनाद् वलितत्वतः ॥ २२६ ॥

[ग्रहणपरिलेखनम्]

बिम्बान्तरसमेनादौ लिखेत् सूत्रेण मण्डलम् ॥ ४६^{b} ॥

बिम्बान्तरं तु सम्पर्कदलं स्यात् स्पर्शमोक्षयोः ।
शलाकाङ्कितमध्या या[1] वलनद्विगुणायता ॥ ४७ ॥

[स्फुटवलनानयनवासना]

वलनद्वितयं चैतत् भिन्नतुल्यविशोः क्रमात् ।
विश्लिष्टमथ युक्तं च स्फुटं वलनमिष्यते ॥ २२७ ॥

बिम्बान्तरव्यासदले वृत्ते तत् कल्पयेत् ततः ।
बिम्बान्तरेण गुणनात् त्रिज्यया हरणादपि ॥ २२८ ॥

भाबाह्वन्तरितं वृत्तं समन्ताद् सममण्डलात् ।
द्युवृत्तवद् ग्राह्यबिम्बघनमध्यस्थनेमिकम् ॥ २२९ ॥

क्रान्तिद्युवृत्ते तद्बिम्बघनमध्यस्थनेमिके ।
भाबाह्वन्तरितं यत्तु तत्राद्यं सममण्डलात् ॥ २३० ॥

तद् द्युवृत्तान्तरं बिम्बनेम्यां वलनमक्षजम् ।
क्रान्तिद्युवृत्तयोर्बिम्बनेम्यां विवरमायनम् ॥ २३१ ॥

तद्विष्टक्षेपयोर्योगभेदतोऽन्तरिते ततः ।
ग्राह्यग्रहस्य परिधौ ग्राहकेण तु गृह्यते ।
वलनं ग्राह्यबिम्बोक्तं वृत्तेऽन्यत्रापि कल्प्यताम् ॥ २३२ ॥

[चन्द्रग्रहणपरिलेखनवासना]

बिम्बान्तरसमेनेति (46b-53)—

ग्राह्यग्राहकयोर्बिम्बान्तरव्यासार्धमण्डले ।
वलनद्वितयं[1] कल्प्यं स्पर्शमोक्षेष्टकालजम् ॥ २३३ ॥

मूलम्—1. C. मध्याया

व्याख्या—1. Mss. read वलनं द्वितीयं

प्राग्रेखागतमध्याङ्कनेमिस्पृष्टोभयाग्रया ।
वलनं नीयतां स्पष्टं यथादिशमथानया ॥ ४८ ॥

प्रत्यग्रेखास्थ[1]मध्याङ्कन्यस्तया व्यस्तमेव च ।
रेखां पूर्वापरां कुर्यात् तद्वशादपि चेतराम् ॥ ४९ ॥

छायामार्गोऽनयोः पूर्वो विक्षेपान्तरिता[2] विधोः ।
रेखाविक्षेपदिक्स्थातो मार्गौ तत्कालजौ तु तौ ॥ ५० ॥

बिम्बान्तरं बिम्बयोगदलं स्यात् स्पर्शमोक्षयोः ।
संस्पर्शे नेमिमात्रेण घनमध्यान्तरं द्वयोः ॥ २३४ ॥

ग्राह्यग्राहकयोर्बिम्बसम्पर्कार्धसमं भवेत् ।
व्यासार्धान्तरिता नेमिः स्वबिम्बघनमध्यतः ॥ २३५ ॥

उभयोरन्तरं तेन सम्पर्कार्धसमं कृतम् ।
निजान्यबिम्बव्यासार्धं स्वव्यासार्धाद् बहिर्यतः ॥ २३६ ॥

अतो बिम्बान्तरं बिम्बयोगार्धं स्पर्शमोक्षयोः ।
बिम्बान्तरव्यासदलमण्डलं प्रथमं लिखेत् ॥ २३७ ॥

तत्र पूर्वापरां रेखां कुर्याद् याम्योत्तरां तथा ।
ततश्चिह्नितमध्यं यद् वलनद्विगुणायतम् ॥ २३८ ॥

तत्पूर्वापररेखास्थमध्यं सूत्रं प्रसारयेत् ।
यथा तन्नेमिसंस्पृष्टं तदग्रद्वितयं भवेत् ॥ २३९ ॥

पौर्णमास्यां प्रतीच्यां तु प्रागेव प्रतिपद्यपि ।
सम्पर्कार्धकृते वृत्ते वलनं स्पर्शमोक्षयोः ॥ २४० ॥

नीत्वा यथादिशं तस्माद् रेखां पूर्वापरां लिखेत् ।
व्यस्तदिक्स्थान्यवलनस्पृष्टाग्रां मध्यभेदिनीम् ॥ २४१ ॥

मूलम्—1. C. प्रत्यग्रेखास्त 2. A. विक्षेपान्तरितं

लिप्ताव्यासदलेनेन्दोः स्वमार्गे परिधौ लिखेत् ।
पौर्णमास्यां प्रतीच्यां तु प्रागेव प्रतिपद्यपि ॥ ५१ ॥

वृत्तमध्ये तमोबिम्बं स्वमार्गे सर्वदा लिखेत् ।
तमोबिम्बाद् बहिर्भूतं दृश्यमिन्दौ न तद्गतम् ।
हनुपार्श्वादिभेदादि दृश्यतामत्र सुस्फुटम् ॥ ५२ ॥

[॥ इति तन्त्रसंग्रहे चन्द्रग्रहणप्रकरणं नाम
चतुर्थोऽध्यायः ॥]

ततः समतिरश्चीनां रेखां याम्योत्तरां लिखेत् ।
छायामार्गोऽनयोः पूर्वा विक्षेपान्तरिता विधोः ॥ २४२ ॥

रेखाविक्षेपविक्स्थातो मार्गौ तत्कालजौ तु तौ ।
लिप्ताव्यासदलेनेन्दोः स्वमार्गे परिधौ लिखेत् ॥ २४३ ॥

पौर्णमास्यां प्रतीच्यां तु प्रागेव प्रतिपद्यपि ।
वृत्तमध्ये तमोबिम्बं स्वमार्गे सर्वदा लिखेत् ॥ २४४ ॥

स्पर्शमध्येष्टमोक्षादि दर्शयेत् तत्र सुस्फुटम् ।
तमोबिम्बाद्बहिर्भूतं दृश्यमिन्दौ न तद्गतम् ॥ २४५ ॥

हनुभेदः[1] पार्श्वभेदस्तत्र भेदान्तराण्यपि ।
करामलकवत् सर्वं दर्शयेत विचक्षणः ॥ २४६ ॥

व्याख्या—1. A. हनुभेदाः

इत्येष परक्रोडावासद्विजवरसमीरितो योऽर्थः ।
स तु तन्त्रसंग्रहस्य प्रोक्तोऽध्याये चतुर्थेऽभूत्[1] ॥ २४७ ॥

[इति तन्त्रसंग्रहस्य पद्यव्याख्यायां युक्तिदीपिकायां
चन्द्रग्रहणप्रकरणं नाम
चतुर्थोऽध्यायः[2] ॥]

व्याख्या—1. C. चतुर्थोऽभूत् । Mss. A. B. C. end with ch. IV.

2. A. तन्त्रसंग्रहः समाप्तः । शुभमस्तु । B. C. इति तन्त्रसंग्रहव्याख्याने चतुर्थोऽध्यायः ।

अथ पञ्चमोऽध्यायः*

रविग्रहणप्रकरणम्

[ग्रहणसम्भवः]

ग्रहे दृश्यार्धमध्यस्थे न किञ्चदपि लम्बनम् ।
तस्माद् दृक्क्षेपलग्नात्[1] स्यात् प्राक् पश्चाद्वा स्थिते ग्रहे ॥१॥

समोर्ध्वगापवृत्तस्थे नतेरपि न सम्भवः ।
तत्क्षेपकोटिवृत्ते क्वाप्यूर्ध्वसूत्रस्पृशि स्थिते ॥ २ ॥

सममण्डलमध्यात्तद्विप्रकर्षे नतिर्भवेत् ॥ ३a ॥

तन्त्रसंग्रहव्याख्या लघुविवृतिः*

[ग्रहणसम्भवः]

अथ सूर्यग्रहणे लम्बनावनतिभ्यां विशेषं प्रदर्शयिष्यन् प्रथमं तावत् तयोः सम्भवभूमिं दर्शयति— [ग्रहे दृश्यार्ध इति ।]

इह खलु सर्वदा प्रवहेण प्रत्यङ्मुखं भ्राम्यमाणस्यापक्रमवृत्तस्य क्षितिजादूर्ध्वगतः खण्डो दृश्यार्धं, [1]अन्यददृश्यार्धम् । तत्र[2] दृश्यार्धस्य स्वसमतिरश्चीनेन खमध्यस्पृष्टेन दृक्क्षेपवृत्तेन सह यत्र सम्पातः तत्र स्थितं तदानीं दृक्क्षेपलग्नम् । तत् पुनः तद्दृश्यार्धमध्यगतमेव । तस्मिन्[3] यदा ग्रहो वर्तते

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* Text-cum-Com. Mss. used : **A.** Ms. with K. V. Sarma. **B.** V. V. R. I. Ms. No. 3810. **C**$_{1-10}$ Mss used in *TSS*, No. 188.

मूलम्— 1. C. लग्नं

व्याख्या—1. C. ततोन्यत् 2. C. तदा

3. C. ततस्तस्मिन्

[दृग्गतिः दृक्क्षेपज्या च]

राश्यष्टमांशलङ्कोत्थप्राणैश्चापि नतासुभिः ॥ ३b ॥

तदा तस्य **न किञ्चिदपि लम्बनं** भवति । ततो **दृक्क्षेपलग्नात् प्राग्**[1] **पश्चाद् वा स्थिते ग्रहे** सम्भवत्येव । अत एव भानुदृक्क्षेपलग्नयोरन्तरालतो लम्बनानयनमुपरिष्टाद् वक्ष्यते ।

तत्र[2] द्रष्टुः **समोपरिवर्तिनि अपक्रममण्डलप्रदेशे** यदा ग्रहो वर्तते[3] तदा **नतेरप्यसम्भवो** बोद्धव्यः । [4]तदिदं खमध्यावसिते विषुवद्वितये भवति । तत्रैव च तदानीं क्रान्तिवृत्तोदयास्तप्रदेशस्पृष्टस्य लग्नसममण्डलस्य मध्यमवतिष्ठते । यदुक्तम्—

> **क्रान्तिवृत्तोदयास्तस्पृक् खमध्यस्पृष्टनेमिकम् ।**
> **अधऊर्ध्वस्थितं वृत्तं स्याल्लग्नसममण्डलम् ॥**

इति ।

ततः क्रान्तिमण्डलात् समन्ततो दृक्क्षेपज्यान्तरितं यत् तत् **कोटिमण्डलम्** । तत् कुत्रचिदधऊर्ध्वं वा खमध्यं स्पृशत्येव । ततस्तस्य **सममण्डलतो** यो **विप्रकर्षः** [5]दृक्क्षेपज्यारूपः तस्मिन् सति तदधीनसिद्धिका **नति**र्भवतीति ॥ १-३a ॥

व्याख्या— 1. C. प्राग्वा 2. C. तदा

3. C. adds here : यथा घटिकामण्डलात् स्वदेशाक्षज्यान्तरितस्य अपक्रमवृत्तभागस्य दक्षिणोत्तरमण्डलस्पृष्टत्वे

4. For तदिदं to विप्रकर्षः 9 lines below, C. reads : कदा पुनः सा नतिः सम्भवतीति चेत्, तस्यापक्रमवृत्तभागस्य खमध्यतो दक्षिणेनोत्तरेण वा यो क्षेपः, तस्य च यत् कोटिवृत्तं दक्षिणेन विक्षिप्तेऽपक्रमवृत्तभागे सति उत्तरं, अन्यथा दक्षिणं, तदवश्यं खमध्यस्पृष्टमेव परिकल्पितव्यम् । क्रान्तिवृत्तोदयास्तलग्नेश(लग्नप्रदेश ?)स्पृष्टं लग्नसममण्डलमपि खमध्यस्पृष्टमेव सर्वदा भवति । अतस्तस्य लग्नसममण्डलस्य खमध्यस्पृष्टभागतो वा क्षेपकोटिवृत्तलग्नसममण्डलयोरूर्ध्वसूत्रस्पृष्टप्रदेशाद्वा तस्यापक्रमवृत्तभागस्य यो विप्रकर्षो

5. C. adds : दृक्क्षेपमण्डलगतो

रवौ क्षयधने कृत्वा मध्यलग्नं स्फुटं नयेत् ।
तस्माद्विषुवदादेः स्वक्रान्तिकार्मुकमानयेत् ॥ ४ ॥

[दृग्गतिः दृक्क्षेपज्या च]

अथ तयोः[1] लम्बनावनत्योर्दृग्गतिदृक्[2]क्षेपज्याद्वयाधीनसिद्धि[3]त्वात् तदानयनायाह— [**राश्यष्टमांशेति ।**]

तत्र **राश्यष्टमांश**तुल्यचापभागस्य ये **लङ्कोदयप्राणाः** प्रागुक्तमार्गेण समानीताः, ये च तदानीं **नतासवो** दिनपूर्वापरार्धयोः दिनार्धप्राणेभ्यो द्युगतप्राणविशोधनेन द्युगतप्राणेभ्यो दिनार्धविशोधनेन[4] च सम्पादिताः, तैरुभयैरपि त्रैराशिकेन **क्षयधनात्मकं** फलद्वयमानीय विधिवद् **रवौ** कुर्यात् । **तन्मध्यलग्नं** भवति ।

तद्यथा—पूर्वाह्णे तावत् तात्कालिकस्य सायनार्कस्य वर्तमानचापखण्डे [5]नतभागान् कलीकृत्य तत्सम्बन्धिभिर्लङ्कोदयप्राणैर्निहत्य चापखण्डेन विभज्य लब्धान् [6]नतप्राणेभ्यो विशोध्य रवेर्गतचापभागं च विशोधयेत् । पुनरपि शिष्टेभ्यो नतप्राणेभ्यो यावतां चापखण्डानां लङ्कोदयप्राणाः ततः प्राक्तना उत्क्रमेण विशोधयितुं शक्याः तावतो विशोध्य चापखण्डानपि तावतः पूर्वागत[7]चापभागविशुद्धाद् रवेः शोधयेत्[8] । [9]पुनरवशिष्टेभ्योऽपि चापखण्डनिहतेभ्य[10]स्तल्लङ्कोदयप्राणैर्विभज्य लब्धाः कलाः तस्मादेव[11] रवेः शोधयेत् । तत्र शिष्टं **मध्यलग्नं** भवति । अपराह्णे पुनस्तात्कालिकस्य सायनार्कस्य गन्तव्यचापखण्डसम्बन्धिनो लङ्कोदयप्राणान् प्राग्वदानीय नतप्राणेभ्यो विशोध्य गन्तव्यचापखण्डं च रवौ प्रक्षिप्य पुनरवशिष्टेभ्यो[12] नतप्राणेभ्यो यावतां चापखण्डानां लङ्कोदयप्राणाः तदूर्ध्वगताः

व्याख्या—1. C. $_{1-6,\ 10}$. ये for तयोः

2. A. om. दृक् 3. C. om. सिद्धि

4. B. दिनार्धप्रविशोधनेन

5. B. om. नत; C. गत 6. C. (except. 9) गत

7. A. पूर्वगत

8. B. Hapl. om. शोधयेत् । [पुनरव to शोधयेत् ।], third line.

9. C. $_{1-6,\ 8\cdot 10}$ पुनरपि

10. C. $_{1-6,\ 10}$ चापखण्डनिर्गतेभ्यः 11. C. om. एव

12. B. C. $_{1-6,\ 8\cdot 13}$ पुनरपि शिष्टेभ्यो

तदक्षचापसंयोगो दिक् साम्येऽन्तरमन्यथा ।
मध्यज्याख्या हि तज्ज्या स्यात् प्राग्लग्नस्याग्रमौर्विका[1] ॥५॥

उदयज्या तयोर्घाता त्रिज्याप्ता[2] बाहुमौर्विका ।
मध्यज्यायास्त्रिजीवायाः कृतिभ्यां तत्कृतिं त्यजेत् ॥ ६ ॥

क्रमेण शोधयितुं शक्याः तावतो विशोध्य चापखण्डानपि तावतो रवौ प्रक्षिप्य शिष्टान् नतप्राणांश्चापखण्डेन निहत्य वर्तमानैर्लङ्कोदयप्राणैर्विभज्य लब्धाः कला अपि प्रक्षिपेत् । एवंकृतो रविर्मध्यलग्नं भवति ।

[1]तस्मान्मध्यलग्नादयनचलनसंस्कारेण उदग्विषुवदादितान्नीतात् क्रान्ति-चापमानीय[2] तस्य स्वदेशाक्षचापस्य च याम्योदग्गोलयोर्योगमन्तरं वा कृत्वा जीवामानयेत् । सा मध्यज्या इत्युच्यते । अथ तात्कालिकमुदयलग्नं च सूक्ष्म-मानयेत् । तत्त प्रागेवोक्तम्—

संस्कृतायनभानूत्थराशिगन्तव्यलिप्तिकाः ।
तद्राशिस्वोदयप्राणहता राशिकलाहृताः ॥

असवो राशिशेषस्य गतासुभ्यस्त्यजेच्च तान् ।
उत्तरोत्तरराशीनां प्राणाः शोध्याश्च शेषतः ॥

मूलम्— 1. B. स्याक्षमौर्विका 2. C. त्रिज्याप्तं

व्याख्या—1. C. adds : इत्येवं सायनार्कस्य ओजपदस्थत्वे सति मध्यलग्नानयनप्रकारः । तस्यैव युग्मपदस्थत्वे पुनः प्राक्कपाले वर्तमानचापखण्डे गतभागसम्बन्धिनो लङ्कोदयप्राणान् नतप्राणेभ्यो विशोध्य रवेर्गतचापभागं च विशोध्य पुनस्तदूर्ध्वोर्ध्वंगतान् लङ्कोदयप्राणान् नतप्राणेभ्यः क्रमेण विशोध्य चाप-खण्डानपि तावतो रवेर्विशोध्य अवशिष्टप्राणसम्बन्धिनश्चापभागानपि विशोध्य मध्यलग्नमानेतव्यम् । अत्रैव अपराह्णे पुनः प्राग्वत् वर्तमान-चापखण्डस्यैष्यभागे पूरणं ततो व्युत्क्रमेण लङ्कोदयप्राणविशोधनं तं तच्चापखण्डप्रक्षेपणं अवशिष्टप्राणसम्बन्धिनश्चापभागप्रक्षेपणं च रवौ कुर्यात् । एवंकृतो युग्मपदस्थो रविर्मध्यलग्नं भवति । यदा पुनर्नतप्राणेभ्यो लङ्कोदयप्राणविशोधने तेषां मध्ये पदसमाप्तिर्भवति तदा तदवशिष्टेभ्यो विशोधने पदान्तरोक्तन्यायमनुसन्धेय इति ।

2, C. 1-6, 8, 10 क्रान्तिश्च मूलमानीय

तन्मूलयोस्त्रिजीवाघ्नामाद्यमन्येन संहरेत् ।
लभ्यते तत्र दृक्क्षेपस्तत्कोटिर्दृग्गतिर्मता ॥ ७ ॥

[लम्बननाडिकाः तत्संस्कारश्च]

एकज्यावर्गतश्छेदो लब्धं दृग्गतिजीवया ।
छेदाप्तान्तरबाहुज्या भानुदृक्क्षेपलग्नयोः ॥ ८ ॥

पूरयित्वा रवे राशिं क्षिपेद्राशींश्च तावतः ।
विशुद्धा यावतां प्राणाः शेषात् त्रिंशद्गुणात् पुनः ॥

तदूर्ध्वराशिमानाप्तान् भागान् क्षिप्त्वा रवौ तथा ।
षष्टिघ्नाच्च पुनः शेषात् तन्मानाप्तकला अपि ॥
एवं प्राग्लग्नमानेयम् ।

(तन्त्रसंग्रहः, ३. ९५b-९९)

इति । तथाऽऽनीतस्य प्राग्लग्नस्य याग्रज्या—

सायनार्कभुजाजीवा परमक्रान्तिताडिता ।
लम्बकाप्ताग्रजीवा स्यात् ।

(तन्त्रसंग्रहः, ३. ३६-३७)

इत्युक्तप्रकारेणानीता[1] सैवोदयज्या । तयोर्मध्यज्ययोदयज्ययोः संवर्गतः[2] त्रिज्यया विभज्य लब्धं[3] बाहुज्या नाम । तस्या बाहुज्याया वर्गं मध्यज्यायास्त्रिज्यायाश्च वर्गतो[4] विशोध्य शिष्टद्वयं मूलीकृत्य तयोराद्यमूलं त्रिज्यया निहत्य द्वितीयमूलेन विभजेत् । तत्र लब्धं दृक्क्षेपज्या नाम । तद्वर्गं त्रिज्यावर्गतो विशोध्य शिष्टस्य मूलं दृक्क्षेपकोटिः । सैव दृग्गतिज्या चेति ॥ ३b-७ ॥

[लम्बननाडिकाः तत्संस्कारश्च]

अथ दृग्गतिज्याया लम्बननाडिकानयनं पर्वान्ते तत्संस्कारप्रकारं चाह— [एकज्यावर्गत इति ।]

मूलम्— 1. B. दृक्क्षेपं

व्याख्या—1. C. ण समानीता 2. C. संवर्गं तं
3. C. लब्धा 4. C. मध्यज्यावर्गतः त्रिज्यावर्गतश्च

लम्बनं नाडिकादिः स्यात् स्वर्णमूनाधिके रवौ ।
पर्वान्ते मुहुरप्येवं पर्वान्तमविशेषयेत् । ९ ॥

[रवेर्नतिकलाः]

अविशिष्टात् तु दृक्क्षेपात् स्फुटभुक्त्याहताद् रवेः ।
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खस्वरेष्वेकभूताप्ता नतिर्दृक्क्षेपवद् दिशा ॥ १० ॥

[चन्द्रस्य नतिकलाः]

तत्कालेन्दुस्फुटात् क्षेपं प्राग्वत् कृत्वा स्फुटं ततः ।
क्षेपदृक्क्षेपचापैक्यात् साम्ये भेदेऽन्तराद् गुणः ॥ ११ ॥

तत्रैकराशिज्यावर्गतो दृग्गतिज्यया विभज्य लब्धः **छेदो** नाम । तेन छेदेन इष्टकाले **भानुदृक्क्षेपलग्नयो**रन्तराल[1]दोर्ज्यां विभज्य लब्धं फलं **लम्बनं नाडिकादिकं** भवति ।[2] तत् **पर्वान्ते** दृक्क्षेपलग्नतो रवेरूनाधिकतावशाद् धनमृणं च कुर्याद् इति । अत्र लम्बनसंस्कृतस्फुटपर्वान्त एव[3] तात्कालिकार्कदृक्क्षेपलग्नादिकं कर्तव्यम् । तत एव च **लम्बन**मिति । अविशेषकरणेनैव स्फुटत्वादुक्तम्— **मुहुरप्येवं पर्वान्तमविशेषये**दिति ॥ ८-९ ॥

[रवेर्नतिकलाः]

अथ लम्बननाडिकानामविशेषे[4] दृक्क्षेपज्याया अप्यविशेषलाभात्[5] तया रवेर्नतिलिप्तानयनायाह— [**अविशिष्टात्विति** ।]

उक्तप्रकारेण **अविशिष्टां दृक्क्षेपज्यां रवेः स्फुटभुक्ति**कलाभिर्निहत्य **खस्वरेष्वेकभूतैः** (५१५७०) विभजेत् । तत्र लब्धा रवेर्नतिकला भवन्ति[6] ॥ १० ॥

[चन्द्रस्य नतिकलाः]

अथ चन्द्रस्यापि नतिलिप्तानयनायाह— [**तत्कालेन्दुस्फुटादिति** ।]

व्याख्या—1. C. रालतो 2. C. Tr. नाडिकादिकं लम्बनं भवति

3. C. पर्वान्तित एव 4. C. मविशेष

5. C. अप्यवशिष्टत्वात्

6. C. adds : तासां दृक्क्षेपज्यावद् दिग्विज्ञातव्या । दृक्क्षेपज्यायाः पुनर्लम्बनाधिक्ये सौम्यत्वं, अन्यदा याम्यत्वं च प्रागेवोक्तमिति ।

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द्वितीयस्फुटभुक्तिघ्नो हृतः खाद्रीषुभूशरैः ।
नतिस्तत्क्षेपयोरैक्यं दिक्साम्येऽन्तरमन्यथा ॥ १२ ॥

तदर्कनतिलिप्तानां दिक्साम्येऽन्तरमेव च ।
दिग्भेदे चैक्यमेव स्यात् स्फुटा सूर्यग्रहे नतिः ॥ १३ ॥

अर्कस्य चेन्नतिः शिष्टा विश्लेषे व्यत्ययेन दिक् ।
चन्द्रस्यैव नतेर्ग्राह्या दिक् तस्याश्चान्यदा सदा ॥ १४ ॥

[रविग्रहणस्य सदसद्भावः परमग्रासप्रमाणं च]

सम्पर्कार्धाधिका सा चेत् ग्रहणं नैव भास्वतः ।
सम्पर्कार्धात् त्यजेदूनां परमग्राससिद्धये ॥ १५ ॥

अविशिष्टेन लम्बनेन[1] कृतसञ्चालनात्[2] तत्कालेन्दुस्फुटात् पातं विशोध्य विक्षेपमानीय प्राग्वदेव मन्दस्फुटकर्णेन निहत्य द्वितीयस्फुटकर्णेन विभज्य लब्धस्य स्फुटविक्षेपस्य यच्चापं तस्य दृक्क्षेपचापस्य च मिथो दिक्साम्यभेदवशाद्[3] योगमन्तरं[4] वा कृत्वा ततो जीवामानीय चन्द्रस्य द्वितीयस्फुटगतिकलाभिर्निहत्य खाद्रीषुभूशरैः (५१५७०) विभजेत् । तत्र लब्धाश्चन्द्रस्य स्फुटा नतिकला भवन्ति । तथाऽऽनीतायाश्चन्द्रस्य स्फुटनतेः स्फुटविक्षेपस्य चास्य दिक्साम्यभेदवशाद् योगमन्तरं वा कृत्वा पुनस्तस्या अर्कनतेश्च दिशोर्भेदे साम्ये च योगमन्तरं वा[5] कुर्यात् । एवंकृता सूर्यग्रहणे स्फुटा नतिर्भवति, अर्केन्द्वोरेकदिशा नतयोर्नत्यन्तरस्यान्यदा तद्योगस्य च स्फुटनतित्वात् । तत्र यदि नत्योरन्तरेऽर्कस्य नतिः शिष्येत तर्हि व्यत्ययेनैव नतेर्दिग् ग्राह्या, अन्यथा यथास्थितैवेति ॥ ११-१४ ॥

व्याख्या—1. C. लम्बकेन　　2. C. सञ्चलनात्

3. A. भेदसाम्यवशात्

4. A. दिशोः साम्ये भेदे च योगमन्तरं; C. दिशोर्भेदे योगं साम्ये चान्तरं

5. C. om. वा

[मध्यग्रहणम्]

रवीन्दुबिम्बसम्पर्कदलात् स्फुटनतेरपि ।
स्थित्यर्धे प्राग्वदानेयं[1] तत्र तत्र च लम्बनम् ॥ १६ ॥

कपालैक्ये तु संयोज्यं स्थित्यर्धे लम्बनान्तरम् ।
लम्बनैक्ये तु तद्भेदे तत् स्थित्यर्धे तु योजयेत् ॥ १७ ॥

प्राक्कपाले क्रमान्न्यूनं स्पर्शकालादिलम्बनम्[2] ।
क्रमेण चाधिकं प्रत्यक्कपाले तेषु लम्बनम् ॥ १८ ॥

[रविग्रहणस्य सदसद्भावः परमग्रासप्रमाणं च]

अथैवमानीतया स्फुटनत्या सूर्यग्रहणस्य सदसद्भावौ परमग्रासप्रमाणं च दर्शयितुमाह— [सम्पर्कार्धाधिकेति ।]

तत्रार्केन्द्वोरवनत्योर्योगान्तरोत्पन्ना येयं स्फुटनतिः[1] प्रदर्शिता[2] सा रवीन्द्वोर्बिम्बसम्पर्कार्धतो यद्यधिका स्यात्, तर्हि तयोः बिम्बनेम्योरितरेतराक्रान्तत्वाभावात् ग्राहकबिम्बावच्छादितग्राह्यबिम्बलक्षणं रवेर्ग्रहणं नैव सम्भवति, हीनत्व एव तत्सम्भवात् ।[3] अत एव परमग्रासप्रमाणमपि तयोरेव बिम्बसम्पर्कार्धतः स्फुटावनतिं विशोध्य शिष्टतुल्यमिति[4] ॥ १५ ॥

[मध्यग्रहणम्]

एवं रवेर्मध्यग्रहणं[5] प्रसाध्य तत्रापि स्थित्यर्धद्वयं चन्द्रग्रहणवदेव कर्तव्यमित्याह— [रवीन्दुबिम्बेति ।]

अत्र रवीन्द्वो[6]बिम्बसम्पर्कार्धतः स्फुटनतेरपि स्थित्यर्धं चन्द्रग्रहणोक्तन्यायेन कर्तव्यम् । तद्यथा—बिम्ब[7]सम्पर्कार्धवर्गतः स्फुटनतेर्वर्गं विशोध्य शिष्टं मूलीकृत्य षष्ट्या निहत्य [8]स्फुटगत्यन्तरकलाभिर्विभजेत् । तत्र लब्धं

मूलम्— 1. C. प्राग्वदानीय 2. B. om. लम्बनम्

व्याख्या—1. A. B. स्फुटगतिः 2. C. om. प्रदर्शिता
3. C. तत्स्वभवात् 4. C. शिष्टं तुल्यमिति
5. C. मध्यमग्रहणं
6. C. has an extra word बिम्बे, here,
7. C. बिम्बे 8. C. adds here द्वितीय

[1]यत्रैतद्विपरीतं स्यात् शोध्यं तल्लम्बनान्तरम् ।
आसन्न उदयान्मोक्षे त्वधिकं मोक्षलम्बनम् ॥ १९ ॥
निशि चेन्मध्यकालोऽत्र[2] विप्रकृष्टश्च मौक्षिकात् ।
मौक्षिकाल्लम्बनात् त्याज्यं तदा स्यान्मध्यलम्बनम् ॥ २० ॥
मोक्षस्थितिदलात् तत्र शोध्यं तल्लम्बनान्तरम् ।
एवमस्तमयासन्ने स्पर्शे तल्लम्बनेऽधिके ॥ २१ ॥
मध्यलम्बनकालात्तु त्याज्यं तत्र तदन्तरम् ॥ २२a ॥

नाडिकादिकं स्थित्यर्धं भवति । तस्य स्पर्शमोक्षद्वयसाधारणत्वात् स्वस्वलम्बन-संस्कारेणैव स्फुटत्वात् लम्बनमानेतव्यम् ।[1]

तद्यथा—तत्र स्पर्शमध्यमोक्षेषु एककपालावस्थितेषु स्पर्शमध्य-लम्बनान्तरं[2] स्पर्शस्थित्यर्धे प्रक्षिपेत् । मोक्षमध्यलम्बनान्तरं च मोक्षस्थित्यर्धे प्रक्षिपेत्[3] ।

स्पर्शमध्ययोर्मोक्षमध्ययोर्वा कपालभेदे[4] लम्बनैक्यं तत् स्थित्यर्धे प्रक्षिपेत् । यस्मात् प्राक्कपाले स्पर्शमध्यमोक्षाणां लम्बनं क्रमान्न्यूनं भवति । प्रत्यक्कपाले पुनः क्रमेण चाधिकमिति । यत्र पुनरेतद्विपरीतं स्यात्, तदा लम्बनान्तरं शोध्यमेव । यथा तत्रैव प्राक्कपाले [5]रव्युदयादधऊर्ध्ववर्तिनोर्ग्रहणमध्य-

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मूलम्— 1. C_7. यद्यैतत् 2. $C_{1 \cdot 6 \cdot 8 \cdot 10}$ कालोक्त

व्याख्या - 1. C. adds here : तत्र प्रथमं साधारणत्वेन आनीतमेतत्स्थित्यर्धं ग्रहण-मध्यकालादविशिष्टस्वलम्बनसंस्कृतपर्वान्ताद्विशोध्य प्रायिकः स्पर्शकाल आनेतव्यः । अथ तस्मिन् स्पर्शकालेऽपि काललग्नादिपुरस्सरं नतिलम्बने समानीय तल्लम्बनं स्थित्यर्धे संस्कुर्यात् ।

2. B. स्पर्शमध्यतया लम्बनान्तरं

3. C. adds here : यदा पुनर्विशेषणीययोर्लम्बनयोरन्यतरस्य शून्यत्वं तदितरलम्बनतुल्यमेव लम्बनान्तरमपि इत्यवगन्तव्यम् । "योगे खं क्षेप-सममिति" न्यायस्य वियोगेऽप्युपलक्षणात् । येन

4. C. कपाले भेदे

5. C. reads the passage as : रव्युदयादधोवर्तिनि मध्यग्रहणे तदूर्ध्व-वर्तिनि च मोक्षे यदा मोक्षस्य उदयासन्नतरत्वं

[स्पर्शकालाविशेषः]

स्थित्यर्धमेवमानीतं स्पार्शिकं[1] पर्वणस्त्यजेत् ॥ २२b ॥

अविशिष्टात् पुनस्तस्मिन् स्पर्शेऽपि नतिलम्बने ।
स्थित्यर्धमपि चानीय तन्नत्यानीतया सकृत् ॥ २३ ॥

स्थित्यर्धं स्पर्शमध्योत्थलम्बनान्तरसंस्कृतम् ।
लम्बनैक्ययुतं वा स्यात् स्पर्शमध्यकपालयोः ॥ २४ ॥

भेदे तेन विहीनो यो मध्यकालोऽविशेषितः[2] ।
तत्रापि सकृदानीय नतिस्थितिदलादिकम् ॥ २५ ॥

लम्बनान्तरमैक्यं वा कुर्यात् स्थितिदलेऽत्र च ।
तेनापि स्पर्शकालादीन् प्राग्वदेवानयेन्मुहुः ॥ २६ ॥

मोक्षयोर्यदा मोक्षस्योपरिवर्तिन उदयं प्रत्यासन्नतरत्वं, ग्रहणमध्यस्य च [1]निशावसानस्थितत्वेपि रव्युदयं प्रति मोक्षकालाद् विप्रकृष्टत्वं, तदा मौक्षिकाल्लम्बनात् मध्यलम्बनं त्याज्यम्, तत्र शिष्टं लम्बनान्तरं मोक्षस्थितिबलाच्छोध्यमेव । तथा प्रत्यक्कपाले स्पर्शे मध्यग्रहणतोऽप्यस्तमयासन्ने स्पर्शलम्बनेऽधिके च सति स्पर्शमध्यलम्बनयोरन्तरं स्पर्शस्थितिदलात् त्याज्यमेव[2] इति ॥ १९-२२a ॥

[स्पर्शकालाविशेषः]

अथ स्पर्शस्थित्यर्धमविशेषयितुमाह[3]—[स्थित्यर्धमिति ।]

तत्रोक्तवल्लम्बनसंस्कृतं स्पर्शस्थित्यर्धं ग्रहणमध्यपर्वान्तादविशिष्टस्वलम्बनसंस्कृताद् विशोधयेत्[4] । स स्पर्शकालो भवति । पुनस्तस्मिन् स्पर्शेऽपि

मूलम् — 1. C. तादृशं 2. C. $_{1\text{-}6\cdot 8\cdot 10}$ काले विशेषतः

व्याख्या—1. C. reads only : निशावसानस्थितस्य विप्रकृष्टत्वं

2. C. शोध्यमेव for त्याज्यमेव

3. B. स्थित्यर्धमपि चानीय तप(?)यितुमाह

4. C. (except 9) संस्कृतादपि शोधयेत्

कालं तं निश्चलीकृत्य मोक्षकालं तथानयेत् ॥ २७a ॥

[मोक्षकालाविशेषः]

अविशिष्टे तु पर्वान्ते स्थित्यर्धं तत् क्षिपेन्मुहुः ॥ २७b ॥

लम्बनान्तरमैक्यं वा मोक्षस्थितिदलेऽपि च ।
तत्तन्नतिकृते कार्यं प्राग्वत्तच्चाविशेषयेत् ॥ २८ ॥

काललग्नादिपुरस्सरं **नतिलम्बने स्थित्यर्धमपि** एकयैवावृत्त्या[1] नीत्वा तस्मिन् स्पर्शस्थित्यर्धे **स्पर्शमध्यलम्बनयोः** कपालैक्यभेदवशाद् विश्लेषं योगं वा प्रक्षिपेत्। यदा पुनः[2] स्पर्शमध्यग्रहणयोर्मध्ये रवेरस्तमयः तदा अस्तमयासन्नतरे स्पर्शे तत्स्थित्यर्धे स्पर्शमध्यलम्बनयोरन्तरं शोधयेत् । तथाकृतं स्पर्शस्थित्यर्धं पूर्वोक्तादेव ग्रहणमध्यपर्वान्ततो विशोधयेत् । पुनरपि तं स्पर्शकालं परिकल्प्य तत्रापि काललग्नाद्यानयनपूर्वकं एकयैवावृत्त्या नतिलम्बने समानीय तत्र स्फुटनतिसिद्धे स्थित्यर्धे पूर्ववत् **लम्बनान्तरमैक्यं वा कुर्यात्** । तथाकृतं स्थित्यर्धं पूर्वोक्तान्मध्यग्रहणपर्वान्ततो विशोध्य पुनरप्येवमेव कुर्यात्, यावदविशेषः । अविशिष्टेन [3]स्थित्यर्धेन विहीनो मध्यग्रहणपर्वान्तः स्फुटः स्पर्शकालो भवति । एवं स्पर्शकालं **निश्चलीकृत्य मोक्षकाल**मप्यविशेषकर्मणैव स्फुटीकुर्यादिति ॥ २२b-२७a ॥

[मोक्षकालाविशेषः]

तदेव दर्शयति — [**अविशिष्ट इति** ।]

तत्र पूर्वानीतमध्यग्रहणत एव[4] यन्मोक्ष**स्थित्यर्धं**, तस्मिंस्तयोर्लम्बनयोर्योगमन्तरं वा प्रक्षिपेत्। मध्यग्रहणतो मोक्षस्य कपालभेदे सति तयोर्लम्बनयोर्योगं, अन्यथा तयोरन्तरं प्रक्षिपेत्। मोक्षे तु रव्युदयादूर्ध्ववर्तिनि तदधोवर्तिनो मध्यकालादुदयासन्ने तयोर्लम्बनयोरन्तरं मोक्षस्थित्यर्धतो विशोधयेत्। तथाकृतं तत्स्थित्यर्धं पूर्वोक्त एव मध्यग्रहणपर्वान्ते[5] कृताविशिष्टस्वलम्बने प्रक्षिपेत्। स मोक्षकालो भवति । ततस्तस्मिन्

व्याख्या—1. C. एकया वृत्त्या 2. C. om. पुनः
3. C. स्पर्शस्थित्यर्धेन 4. C. adds पूर्वानीतं
5. A. adds एव

तद्युते[1] मध्यकालेऽस्य मोक्षो वाच्यो विवस्वतः ॥ २९a ॥

[विमर्दार्धं निमीलनोन्मीलनं च]

चन्द्रबिम्बाद् रवेर्बिम्बे त्यक्ते शिष्टस्य यद्दलम् ॥ २९b ॥

ततः स्फुटनतिर्हीना यदि स्यात् सकलग्रहः ।

चन्द्रबिम्बे रवेर्बिम्बात् त्यक्ते शिष्टस्य यद्दलम् ॥ ३० ॥

मोक्षकालेऽपि[1] काललग्नादिपुरस्सरमेकयैवावृत्त्या[2] नतिलम्बने समानीय तत्स्फुटनत्युत्पन्न[3]मोक्षस्थित्यर्धे पूर्ववद् ग्रहणमध्यमोक्षद्वयोत्पन्नयोर्लम्बनयोरन्तरमैक्यं[4] वा विधिवत् कुर्यात् । ततस्तेन स्थित्यर्धेन युक्ते ग्रहणमध्यपर्वान्ते पुनरपि काललग्नपूर्वकमेकयैवावृत्त्या[5] नतिलम्बने समानीय स्फुटं स्थित्यर्धमप्यानयेत् । ततो मोक्षकालं, ततोऽपि स्थित्यर्धमेवं[6] मुहुः कुर्याद् यावदविशेषः । अविशिष्टेन मोक्षस्थित्यर्धेन संयुक्तो मध्यग्रहणकालस्फुटो **मोक्षकालो** भवतीति । तत्रैव काले[7] **विवस्वतो मोक्षो** वाच्यः । मोक्षग्रहणं स्पर्शस्याप्युपलक्षणम् । तेनाविशिष्ट एव स्पर्शकाले [8]तत्स्पर्शोऽपि वक्तव्य इति ॥ २७b-२९a ॥

[विमर्दार्धं निमीलनोन्मीलनं च]

अथ सकलान्तर्ग्रहयोर्विमर्दार्धान्तर्ग्रहार्धानयन[9]पूर्वकं निमीलनोन्मीलने पूर्तिच्छेदौ च प्रदर्शयितुमाह— [**चन्द्रबिम्बादिति** ।]

तत्र अर्कग्रहणे ग्राह्यात् स्वबिम्बाद् ग्राहके **चन्द्रबिम्बेऽ**धिके सति ततोऽर्कबिम्बं विशोध्य **शिष्टार्धतः स्फुटनतेर्हीन**संख्यत्वे कात्स्र्न्येन ग्रहणं बोद्धव्यम् । अर्थात् तत्तुल्यत्वेऽपि[10] **सकलग्रहण**मेवेति । अथ **चन्द्रबिम्बे रवेबिम्बात् त्यक्ते शिष्टस्य** यदर्धं ततः[11] स्फुटनतेर्हीनसंख्यत्वे सति अन्तर्ग्रह एव भवति । अत एव तत्र बिम्बान्तर्भागस्यैव गृहीतत्वात् समन्ततस्तत्परिधि-

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मूलम् —1. B. तद्युक्ते

व्याख्या—1. A. C.₉ स्पर्शकालेऽपि 2. C. मेकैकया वावृत्त्या

3. C. न्नं 4. C. मोक्षयोर्लम्बनान्तरमैक्यं

5. C. पूर्वकमेकावृत्त्यैव 6. C. इति for एवं

7. B. तत्रैव कालो 8. C. om. तत्

9. B. ग्रहणार्धानयन; C. ग्रहानयन 10. A. अथार्कात्तुल्यत्वेऽपि

11. C. तत् for ततः

ततो यदि नतिर्हीना दृश्या स्यात् परिधिस्तदा ।
बिम्बे भेदार्धवर्गात्तु नतिवर्गोनितात् पदम् ॥ ३१ ॥

षष्टिघ्नं गतिभेदाप्तं विमर्दार्धं रवेरपि ।
चन्द्रेऽल्पेऽन्तर्ग्रहार्धं स्यात् प्राग्वत् ते चाविशेषयेत् ॥ ३२ ॥

मध्यकालाद् विमर्दार्धे शुद्धेऽत्रापि निमीलनम् ।
क्षिप्ते चोन्मीलनं तद्वत् पूर्तिश्छेदश्च नेमिगः ॥ ३३ ॥

[ग्रहणस्य दृक्संवादः]

द्रष्टुर्भूपृष्ठगस्येन्दुबिम्बोऽर्काच्च महान् भवेत् ।
नानात्वात् प्रतिदेशं तन्नेयं बिम्बं स्वदेशजम् ॥ ३४ ॥

दृश्यते । तत्र ग्राह्यग्राहकयोर्बिम्बभेदस्य यदर्धं तस्य स्फुटनतेश्च वर्गान्तरमूलं षष्टया निहत्य अर्कचन्द्रयोः [1]स्फुटगत्यन्तरेण विभजेत् । तत्र लब्धं **रवेर्ग्रहणे विमर्दार्धं** भवति । अपिशब्देन चन्द्रग्रहणेऽप्येवमेव विमर्दार्धमानेतव्यमिति दर्शितम्[2] । तत्र **चन्द्रबिम्बेऽल्पे** सति तथानीतमन्तर्ग्रहार्धं वेदितव्यम् । **ते च** विमर्दार्धान्तर्ग्रहार्धे स्थित्यर्धवदेवा**विशेषयेत्**[3] । **अत्रापि** ग्रहण**मध्यकालाद् विमर्दार्धे** त्यक्ते **निमीलनं, क्षिप्ते च उन्मीलनं,** [4]अन्तर्ग्रहार्धे त्यक्ते **पूर्तिः** क्षिप्ते **छेदश्च**[5] ग्राह्यबिम्ब**नेमिगो**[6] बोद्धव्य इति[7] ॥ २९b-३३ ॥

[ग्रहणस्य दृक्संवादः]

एवं रवीन्द्वोर्बिम्बद्वयनतिविक्षेपाणां भगोलगतत्वमाश्रित्य ग्रहणसदसद्भाव-सर्वग्रास-मध्यतमांसि प्रदर्शितानि । इदानीं दृग्गोलगतैरेव [8]तैर्दृक्संवाद[9]लाभात् तदानयनायाह— [**द्रष्टुरिति** ।]

व्याख्या—1. C. adds द्वितीय   2. C. दर्शयति
3. C. वदविशेषणीये   4. C. adds तथा
5. A. त्यक्ते पूर्तिः छेदश्च; B. त्यक्ते क्षिप्ते च पूर्तिः छेदश्च
6. C. (except 9) नेमिगौ
7. C. (except 9) बोद्धव्यौ इति ।
8. A. om. तैः   9. C. (other than 6. 9) सम्पात

मध्यकालभुजाज्यायाः प्राग्वद् दृक्क्षेपमानयेत् ।
भानोर्दृक्क्षेपलग्ना ज्या हता दृक्क्षेपशङ्कुना ॥ ३५ ॥

त्रिज्याप्ता दृग्गतिर्भानोर्यत्तद् दृक्क्षेपवर्गयोः ।
योगात् पदं तदैक्योनं त्रिज्यावर्गाच्च यत् पदम् ॥ ३६ ॥

छायाशङ्कू रवेस्ताभ्यां भूव्यासार्धस्य योजनैः ।
हताभ्यां त्रिज्यया लब्धे दोःकोटी योजनात्मिके ॥ ३७ ॥

तत्र तावद् घनभूमध्यकेन्द्रके[1] वृत्ते यानि बिम्बादीनां मानानि प्रदर्शितानि, तान्येव भूपृष्ठावस्थितद्रष्टृदृक्केन्द्रके दृग्गोलाख्ये वृत्ते समानीयमानानि महत्त्वमेवोपयान्ति । तत्रापि इन्दुबिम्बोऽर्कबिम्बादतीव महान् भूपृष्ठसन्निहितत्वात् । प्रतिदेशं नानारूपत्वात्, तत्पुनः[2] स्वदेशजमेव बिम्बादिकमानेतव्यम् । तदिदं दृक्कर्णायत्तमिति प्रथमं दृक्कर्णमानयेत् ।

तद्यथा - मध्यकालभुजाज्यायाः[3] काललग्नकोटिज्यारूपायाः स्वदेशलम्बकेन निहत्य [4]करार्थाब्ध्युरगैः (८४५२) विभज्य यल्लब्धं यच्चान्त्यद्युज्याक्षज्ययोर्घातात् त्रिज्यया विभज्य लब्धं तयोः काललग्नस्य मृगकर्क्यादिवशाद् योगं विश्लेषं वा कुर्यात् । सा दृक्क्षेपज्या । सा पुनः फलयोर्विश्लेषे लम्बजफलस्य शिष्टत्वे सौम्या,[5] अन्यदा [सर्वदा[6] दक्षिणा एव, तस्याः स्वदृक्क्षेपज्यायास्त्रिज्यायाश्च[7] वर्गान्तरमूलं दृक्क्षेपकोटिरिति[8] । एतत्सर्वं प्राग्वदित्यनेन दर्शितम् ।

ततो दृक्क्षेपलग्नतोऽर्कस्य यान्तरालदोर्ज्या सा दृक्क्षेपशङ्कुना दृक्क्षेपकोट्या निहता त्रिज्यया विभक्ता भानोर्दृग्गतिज्या भवति । तस्या दृग्गतिज्याया दृक्क्षेपज्यायाश्च यो वर्गयोगः, यश्च तदूनत्रिज्यावर्गः तयोर्ये[9] मूले क्रमेण रवेः छायाशङ्कू स्यातामिति । तौ छायाशङ्कू पृथग् भूव्यासार्धयोजनैर्निहत्य त्रिज्यया विभजेत् । तत्र लब्धे क्रमेण दोःकोटिफले योजनात्मके स्याताम् । तत्र [छायातो लब्धं दोःफलं, शङ्कोर्लब्धं कोटि-

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व्याख्या—1. C. $_{1-8\cdot10}$ केन्द्रे 2. C. तस्मात्
3. B. भुजज्यायाः 4. A. कामार्था; C. $_{1-8\cdot10}$ करार्का
5. C. सौम्यदिक्का 6. C. om. सर्वदा
7. A. तस्या स्वदृक्क्षेपज्यायाश्च ; C. तस्यास्त्रिज्यायाश्च
8. C. $_{1-8\cdot10}$ मूलमिति 9. C. om. ये

रविभूम्यन्तरात् कोटिं त्यक्त्वा तद्बाहुवर्गयोः ।
योगात् पदं भवेद् भानोर्दृक्कर्णो योजनात्मकः ॥ ३८ ॥
क्षेपदृक्क्षेपचापैक्यं नतिः साम्येऽन्यथान्तरम् ।
राशित्रयं यदूनं यत् तज्ज्या शङ्कुः पराभिधः ॥ ३९ ॥
चन्द्रोनलग्नबाहूना त्रिज्या जूकादिजान्विता ।
क्षेपकोट्या हता भक्ता त्रिज्यया बाण उच्यते ॥ ४० ॥
ततो दृक्क्षेपकोटिघ्नं[1] त्रिज्याप्तं परतस्त्यजेत् ।
शेषः शङ्कुः शशाङ्कस्य ततो दृग्ज्या च पूर्ववत् ॥ ४१ ॥
भूव्यासार्धहते[2] ते च त्रिज्याप्ते कोटिदोःफले ।
दृक्कर्णोऽर्कवदिन्दोस्तत् स्वभूम्यन्तरयोजनैः ॥ ४२ ॥

फलमिति । तत्र कोटिफलं **रविभूम्यन्तराद्** रवेर्द्वितीयस्फुटयोजनकर्णाद्विशोध्य शिष्टस्य तद्दोःफलस्य च **वर्गयोर्योगपदं रवेर्योजनात्मको दृक्कर्णो** भवति। एवं रवेर्दृक्कर्णयोजनानयनम् ।

अथ चन्द्रस्यापि पूर्ववदानीतदृक्क्षेपचापस्य तत्कालकेवलसायनचन्द्रसमुद्भूतविक्षेपचापस्य च दिक्साम्यभेदवशाद् योगमन्तरं वा कृत्वा **राशित्रयाद्विशोध्य** शिष्टचापस्य या **ज्या** सा[1] **परशङ्कुर्नाम** । ततस्तदानीं लग्नत: केवलं सायनेन्दुं विशोध्य शिष्टे मेषादिगते सति तद्दोर्ज्यां त्रिज्यातो विशोधयेत् । तुलादिगते सति त्रिज्यायां प्रक्षिपेत् । एवंकृतां दोर्ज्यां **विक्षेपकोट्या** निहत्य **त्रिज्यया** विभज्य लब्धो **बाण इत्युच्यते** । तस्माद् बाणाद् **दृक्क्षेपकोटिगुणितात् त्रिज्यया** विभज्य लब्धं फलं पूर्वानीतपरशङ्कोर्विशोधयेत् । तत्र शिष्टश्चन्द्रस्येष्टशङ्कुः स्यात् । **ततो दृग्ज्या च पूर्ववत्** तत्त्रिज्यावर्गविश्लेषमूलेनैव कर्तव्या । तथाकृते चन्द्रस्य शङ्कुच्छाये पृथग्**व्यासार्धयोजनै**र्निहत्य **त्रिज्यया** विभजेत् । तत्र लब्धे[2] क्रमेण इन्दो:[3] **कोटिदोःफले** स्याताम् । ततो **दृक्कर्णोऽपि अर्कवदेव** कर्तव्यः । यस्मात् तदेव[4] कोटिफलं चन्द्रस्य द्वितीयस्फुटयोजनकर्णतो विशोध्य शिष्टस्य

मूलम्— 1. B. कोटिघ्न; C. कोटिघ्ना　2. C. (other than 6, 9) गते

व्याख्या—1. A. B. स　2. C. 1-6-8-10. विभज्य लब्धे

3. A. तस्यैव for इन्दो　4. C. मतस्तदेव

त्रिज्याघ्नाद् योजनव्यासात् तेनाप्ता बिम्बलिप्तिकाः ।
इष्टेन्दुः समलिप्तेन्दोर्द्वितीयस्फुटभोगतः ॥ ४३ ॥

इष्टकेवलपर्वान्तद्युगतान्तरकालजात् ।
विक्षेपः केवलाच्चन्द्रात् प्राग्वत् त्रिज्याहृतो हतः ॥ ४४ ॥

योजनैर्विवरे चन्द्रभगोलघनमध्ययोः ।
दृक्कर्णयोजनैर्भक्तो दृग्गोले क्षेप इष्यताम् ॥ ४५ ॥

केवलादेव दृक्क्षेपात् भूव्यासार्धेन ताडितात् ।
विधोर्योजनदृक्कर्णभक्तात्र नतिलिप्तिकाः ॥ ४६ ॥

तद्वदेव च दृक्क्षेपात् स्वदृक्क्षेपेन[1] भास्वतः ।
रवीन्द्वोर्नतिभेदः स्यात् सर्वदैवं[2] नतिर्विधोः ॥ ४७ ॥

तद्दोःफलस्य च वर्गयोगमूलं चन्द्रस्य दक्कर्णो योजनात्मको भवति इति। ततो रवीन्द्वोर्बिम्बयोजनव्यासौ पृथक् त्रिज्यया निहत्य स्वस्वदृक्कर्ण-योजनैर्विभजेत् । तत्र लब्धा दृग्गोलगता बिम्बलिप्ता भवन्ति ।

अथ लम्बनाद्यविकृतपर्वान्तस्य इष्टकालस्य चान्तरनाडिका द्वितीयस्फुट-भुक्तिकलाभिर्निहत्य षष्टया विभज्य लब्धाः कलाः समलिप्तचन्द्रे तदिष्टकालस्या-धिकोनतावशाद् धनमृणं वा कुर्यात् । ततस्तस्मादेव केवलचन्द्रतः प्राग्वद्विशुद्ध-पाताद् दोर्ज्यामानीय परमक्षेपेण निहत्य त्रिज्यया विभज्य लब्धं फलं पुनरपि चन्द्रभगोलघनमध्ययोर्विवरेण[1] मन्दस्फुटयोजनकर्णेन निहत्य तस्यैव दृक्कर्णयोजनैर्विभजेत् । तत्र लब्धो दृग्गोल[2]विक्षेपो भवति ।

ततो दृक्क्षेपमपि चन्द्रस्य विक्षेपं विना केवलमेव भूव्यासार्धयोजनैर्निहत्य तस्यैव दृक्कर्णयोजनैर्विभजेत् । तत्र लब्धा दृग्गोले नतिकला भवन्ति । एवं रवेरपि दृक्क्षेपतो भूव्यासार्धयोजनैर्निहतात् तस्यैव दृक्कर्णयोजनैर्विभजेत् ।

मूलम्— 1. C. 1-8·10 स्वदृक्कर्णेन 2. C. सर्वदैव

व्याख्या—1. C. मध्ययोरन्तरेण 4. C. दृग्गोले

तद्भूपृष्ठोदितक्षेपयुतिः साम्येऽन्यथान्तरम् ।
एवं भूपृष्ठगां नीत्वा [1]नतिं बिम्बद्वयं तथा ॥ ४८ ॥
सर्वग्रासो विनिर्णेयो नाम्ना मध्यतमस्तथा ।
ग्रहणं वाप्यभावो वा वाच्यो मानैः स्फुटैरिह ॥ ४९ ॥

[ग्रहणमध्यम्]

तत्कालचन्द्रदृक्क्षेपलग्नान्तरभुजागुणात् ।
अर्कवद् दृग्गतिः साध्या भूव्यासार्धहते तयोः ॥ ५० ॥
दृग्गती[2] स्वस्वदृक्कर्णयोजनैर्विहृते कलाः ।
धनं[3] दृक्क्षेपलग्नात् प्राक् सूर्येन्द्वोर् ऋणमन्यथा ॥ ५१ ॥

तत्र लब्धाः[1] तस्य नतिकलाः । तयोर्दृग्गोलगतयोर्नत्योः दिग्भेदसाम्यवशाद् योगमन्तरं वा कुर्यात्[2] । सा विधोः स्फुटनतिर्भवति । एवमानीतायाः स्फुटनतेः भूपृष्ठसम्पादितस्य विक्षेपस्य च दिक्साम्यभेदवशाद् योगोऽन्तरं वा सूर्यग्रहणे स्फुटतरा नतिर्भवति । एवं भूपृष्ठगां स्फुटनतिं बिम्बद्वयमप्यानीय स्फुटैस्तन्मानैरेव ग्रहणसदसद्भावसमस्तग्रहान्तग्रहादिकं[3] सकलं वाच्यमिति ॥ ३४-४९ ॥

[ग्रहणमध्यम्]

अथार्केन्द्वोर्बिम्बयोरत्यन्तसन्निकर्षलक्षणस्य ग्रहणमध्यस्य प्रदर्शनायाह— [तत्कालचन्द्रेति ।]

तत्र यथा तत्कालार्कदृक्क्षेपलग्नयोरन्तराल[4]दोर्ज्यातो दृक्क्षेपकोट्या निहतया त्रिज्यया विभज्य लब्धा दृग्गतिज्या च स्यात् । तथा तत्कालेन्दु-

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मूलम्— 1. A. C. $_{1-8\cdot10}$ नति for नतिं   2. C. दृग्गतिः
3. C. धन for धनं

व्याख्या —1. C. विभज्य लब्धाः for तत्र लब्धाः
2. C. $_{1-8\cdot10}$ नत्योः सर्वदान्तरमेव कुर्यात् ।
3. C. ग्रहान्तादिकं
4. A. B. Hapl. om. of रन्तराल to रन्तराल, two lines below.

एवंकृतार्कशीतांश्वोः साम्ये स्यात् सन्निकृष्टता ।
कृतलम्बनलिप्तार्कचन्द्रयोर्विवरस्य च ॥ ५२ ॥
कृत्योः स्फुटनतेश्चैक्यात्[1] मूलं बिम्बान्तरं ग्रहे ॥ ५३a ॥

[ग्रहणानादेश्यता]

एवमस्तमये स्पर्शे मोक्षे वाप्युदये रवेः ॥ ५३b ॥
अल्पश्चेद् ग्रास आनीतो न वाच्यो द्वादशांशतः ।
अल्पेऽर्कगतितिथ्यंशयुताल्पव्यासखण्डतः[2] ॥ ५४ ॥

दृक्क्षेपलग्नयोरन्तरालदोर्ज्याया अपि तद्वदेव दृग्गतिः साध्या । ततस्तयोरुभयोरपि दृग्गतिज्ये भूव्यासार्धयोजनैर्निहत्य [1]स्वस्वदृक्कर्णयोजनैर्विभजेत् । तत्र लब्धा [2]यथास्वं लम्बनकलाः भवन्ति । ता[3] लम्बनकलाः सूर्येन्द्वोदृक्क्षेपलग्नतः प्राग्गतयोः प्रक्षिपेत्, प्रत्यग्गतयोर्विशोधयेत् । एवं कृतलम्बनयोरर्कचन्द्रयोः[4] साम्ये सत्येव तद्बिम्बघनमध्ययोः परः[5] सन्निकर्ष इति । तत्रैव ग्रहणमध्येनापि भाव्यम् । कृतलम्बनयोरर्कचन्द्रयोर्विवरकलानां स्फुटनतिकलानां च वर्गैक्यमूलं रवेर्ग्रहणे बिम्बान्तरं भवति । तथाकृतेनैव बिम्बान्तरेण स्पर्शमोक्षेष्टग्रासादिकं सर्वं निर्देष्टव्यमिति ॥ ५०-५३a ॥

[ग्रहणानादेश्यता]

एवं स्पर्शमोक्षेष्टग्रासादिरूपं ग्रहणं विस्तरतः प्रदर्शितम् । इदानीं सम्भविनोऽप्यस्य क्वचिदनादेश्यतामाह— [एवमस्तमय इति ।]

उक्तवदानीतबिम्बान्तरविहितसम्पर्कार्धविशिष्टलक्षण इष्टग्रासो यदा रवेरस्तमयासन्ने स्पर्शे तदुदयासन्ने मोक्षे वा रवि[6]बिम्बव्यास[7]द्वादशभागादल्पो

मूलम्— 1. $C_{1-8\cdot10}$ चैक्यम् 2. C_{1-8} खण्डकः

व्याख्या—1. C. om. one स्व 2. C. यथा स्वलम्बन

3. C. ताश्च

4. A. Hapl. om. of चन्द्रयोः to चन्द्रयोः, two lines below.

5. B. परस्परं 6. C. om. रवि

7. B. व्यासाद् for व्यासः; C. om. व्यास

शङ्कौ मध्यतमः सर्वग्रहणं वा न लक्ष्यते ।
अस्तोदयार्कचन्द्रौ तत्प्राणभोगोनसंयुतौ[1] ॥ ५५ ॥

कृत्वा तत्काललग्नं तैर्नयद् बिम्बान्तरे[2] द्वयोः ।
अधिके बिम्बभेदार्धात् प्राक् पश्चाद् ग्रासमध्यतः ॥ ५६ ॥
नैव ते ग्रहणे दृश्ये सर्वे[3] मध्यतमोऽपि वा ॥ ५७a ॥

[ग्रहणपरिलेखनम्]

स्पर्शे मध्ये च मोक्षे चाप्यन्यत्रेष्टेऽपि वा पृथक् ॥ ५७b ॥

भवति, तदा तद्ग्रहणं सदपि न वक्तव्यम् । ग्रस्तांशस्य अत्यल्पत्वाद्, अनादेश्यत्वात् ।

किञ्च यत्र अर्केन्द्वोरल्पबिम्बस्य व्यासार्धतोऽर्कगतेः पञ्चदशांशेन तल्लम्बनेन युतात् तत्कालशङ्कुरल्पो भवति तत्र सम्भवदपि **मध्यतमस्कं[1] सर्वग्रहणं वा न लक्ष्यते**, भूपृष्ठव्यवहितत्वात्, तस्य इष्टग्रासः पुनस्तत्र लक्ष्येतापीति[2] ।

अपि च उदयास्तमयासन्ने तत्रैव **मध्यतमसि सर्वग्रहणे**[3] वा चन्द्रार्का-वुभावपि उदयास्तमये वा समानीय तयो[4]रिष्टकालसम्बन्धिनां गतगन्तव्य-प्राणानां गतेः क्षेपशोधने च **कृत्वा** ताभ्यां विधिवत्कृतप्राणकलान्तरचरा-सुभ्यां गतगन्तव्यप्राणैश्च काललग्नद्वयमानीय तयोरुभयोरपि स्वदृक्क्षेप-लग्नान्तरालदोर्ज्यया दृग्गतिज्यानयनपूर्वकं लम्बनकलाः समानीय तयोर्विधिवत्-कृत्वा तदन्तरालकलासु वर्गीकृतासु स्फुटावनतेर्वर्गं प्रक्षिप्य मूलीकृतं यद् बिम्बान्तरालं तस्मिन् **द्वयोर्बिम्बविश्लेषार्धादधिके** सति सकलग्रहणं **मध्यतम-स्कमपि**[5] **नैव** दृश्यं, अल्पे सत्येव तयोस्तथादृश्यमानत्वादिति ॥ ५३b-५७a ॥

[ग्रहणपरिलेखनम्]

एवं प्रतिदेशं प्रतिक्षणं च भिन्नरूपं सूर्यग्रहणं विस्तरतः प्रदर्शितम् । सम्प्रति तदेव परिलेखनेन स्पष्टीकर्तुमाह— [**स्पर्शे मध्ये चेति** ।]

मूलम्— 1. C. भोगेन संयुतौ 2. C. बिम्बान्तरं
3. A. सर्व for सर्वे

व्याख्या—1. C. 1-6·8·10 तमसं 2. C. 1-8·10 लक्ष्यतामिति
3. C. 1-8·10 सर्वग्रहणो 4. C. समानीतयो
5. C. 1-6·10 तमस्तमोऽपि

वलनद्वयमानीय प्राग्वत् तद्योगभेदजात् ।

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गुणादेकाङ्कभूभक्तं वलनं स्यात् स्फुटं त्विह ॥ ५८ ॥

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वृत्तं धृतिमितास्येन कर्कटेन लिखेत्[1] क्षितौ ।

दिशौ पूर्वापरे व्यस्तं लेखने फलके यदि ॥ ५९ ॥

तत्र सूर्यग्रहणे **स्पर्शे मध्ये मोक्षेऽपि वा** ततोऽन्यत्रेष्टग्रासे वा प्रोक्तरूपं **वलनद्वयमानयेत्** । **प्राग्वदि**त्यनेनात्राप्यक्षज्यानिहताया नतज्याया[1] त्रिज्यया वा आप्तफलस्य यच्चापं पूर्वापरकपालयोः क्रमेण सौम्ययाम्यदिक्कं आक्षं वलनं तथा राशित्रययुताद् ग्राह्याद् रवेर्दोर्ज्यां परमक्रान्त्या निहत्य त्रिज्यया विभज्य लब्धस्य यच्चापं तस्यैवायनसमानदिक्कं[2] आक्षं वलनमिति पूर्वोक्तं सर्वं स्मारितं, ततस्तयोर्वलनयोर्दिक्साम्यभेदवशाद् योगमन्तरं वा कृत्वा दोर्ज्यामानीय तत **एकाङ्कभूमि(191)भक्तं स्फुटं वलनं** स्यादिति । **इहे**त्यनेन अस्य चन्द्रग्रहणवलनतो भेदो दर्शितः, यतस्तत्र बिम्बान्तरेण निहत्य त्रिज्यया विभक्तं स्फुटं वलनम् ।

अथ त्रिज्यात (3438) एकाङ्कभू(191)भागस्य **धृति**(18)सङ्ख्यत्वात्[3] । तत्तुल्याग्रद्वयविवरेण **कर्कटेन** समभुवि **फलके** वा **वृत्तं** विरचय्य तद्वृत्तमध्याव-भेदिनीं पूर्वापररेखां दक्षिणोत्तररेखां च[4] कुर्यात् । फलके पुनः पूर्वापरदिशौ व्यस्तं परिकल्पयितव्ये[5] । यत उत्तानीभूतं[6] फलकमुद्धृत्य[7] अधोमुखं कृत्वैव तत्रेष्टग्रासादिप्रदर्शनं क्रियते । अतः पूर्वापरदिशोः विपर्यासः स्यादिति । ततस्तथा विरचिते दिग्रेखाङ्किते वृत्ते यथादिशं स्फुटवलन-मपि नयेत् । **पूर्ववदि**त्यनेनात्रापि वलनद्विगुणायतया वृत्तपरिधिस्पृष्टो[8]-भयाग्रया तत्पूर्वापररेखास्थमध्याङ्कया शलाकया तत्परिधावेव यथादिशं वलनस्य नयनं वृत्तापरभागेऽपि तत्पूर्वापररेखातः [9]तद्विपरीतदिशि च बिन्दुविरचनं तदुभयस्पृष्टवृत्तमध्यावगाढप्रागपररेखाविरचनं तद्विपरीत-

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मूलम्— 1. C. कर्कटेनालिखेत्

व्याख्या—1. C. नतज्यया 2. B. तस्यैवायनात् दिक्कं 3. C. संख्यः स्यात्

4. C. भेदिन्यौ पूर्वापरदक्षिणोत्तररेखे 5. C. व्यस्तमेव परिकल्पयेत्

6. C. उक्तवदानीतं 7. C. भूफलकं समुद्धृत्य

8. C. 1-6·8-10 परिस्पृष्टो

9. B. Hapl. om. after तद्विपरीत to तद्विपरीत, next line.

वलनं पूर्ववन्नीत्वा रवेः पन्थाश्च तद्वशात् ।
नतेर्दिशि विधोस्तस्मात् स्फुटनत्यन्तरे परः ॥ ६० ॥

कार्यस्तद्वृत्तमध्येऽथ रविबिम्बं स्फुटं लिखेत् ।
मात्वा तत्केन्द्रगैकाग्रबिम्बान्तरशलाकया ॥ ६१ ॥

बिन्दुं कृत्वा विधोर्मार्गे तद्बिम्बं तत्र संलिखेत् ।
स्पर्शे प्रत्यङ्मुखीं मोक्षे शलाकां प्राङ्मुखीं नयेत् ॥ ६२ ॥

एवमेवेष्टकालेऽपि प्राक् पश्चाद् ग्रासमध्यतः ।

रेखाविरचनं च सर्वं पूर्वोक्तं स्मारितम् । ततः[1] तथाकृतायाः पूर्वापररेखायाः पार्श्वतो यथादिशं स्वावनत्यन्तरितामपरामपि प्रागपरां रेखां कुर्यात् । स इह रवेर्मार्गः ।

ततश्चन्द्रार्कयोरवनत्योर्योगान्तरोत्पन्नस्फुटावनतितुल्येऽन्तरे तद्दिश्यपरामपि प्रागपरां रेखां कुर्यात् । स विधोमार्गः । एवंकृतयोस्तयोर्मार्गयोस्तस्य धृतिमितव्यासार्धवृत्तस्य मध्ये रविबिम्बं[2] स्ववृत्तव्यासार्धेन स्फुटतरं लिखेत् । ततस्तस्यापि बिम्बस्य घनमध्यतो विधोमार्गे बिम्बान्तरशलाकया बिन्दुं नीत्वा विधोर्बिम्बमपि तत्र संलिखेत् । तत्र स्पर्शे प्रत्यङ्मुखीमेव बिम्बान्तरशलाकां नीत्वा तन्मार्गे चन्द्रबिम्बमालिखेत् । ग्राह्यादर्कबिम्बाद् ग्राहकस्य चन्द्रबिम्बस्य प्रत्यग्गतत्वात् । मोक्षे पुनः प्राङ्मुखीं नीत्वा तत्रैव तद्बिम्बमालिखेत् । प्राग्गतत्वात् चन्द्रबिम्बस्य ।

इष्टग्रासेऽप्येवमेव ग्रहणमध्यकालतः[3] पूर्वापरकालानुबन्धितया पश्चान्मुखं प्राङ्मुखं च स्वमार्गेण चन्द्रबिम्बस्य रविबिम्बतो बिम्बान्तरेण विप्रकृष्य विलेखनं स्पर्शमोक्षानुसारेण कर्तव्यम् । एवंलिखिते सत्यर्केन्द्वोर्बिम्बद्वये चन्द्रबिम्बतो बहिर्भूतोऽर्कबिम्बभागो भूपृष्ठावस्थितैर्द्रष्टुं शक्यः । तदन्तर्गतः पुनः तद्भागो नैव दृश्यः । चन्द्रबिम्बेन ग्रस्तत्वादसितत्वादिति ।

व्याख्या—1. C. तत्र 2. C. बिम्ब

3. B. मध्यग्रहणकालतः

चन्द्रबिम्बाद् बहिर्भूतो भागो दृश्योऽर्कमण्डले ।
तदन्तर्गतभागस्तु ग्रस्तस्तेनासितः सदा ॥ ६३ ॥

[इति तन्त्रसंग्रहे रविग्रहणप्रकरणं नाम
पञ्चमोऽध्यायः ॥]

सर्वेत्यनेनैवं[1]क्रियमाणस्य परिलेखनस्य दृक्सम्पर्कादौचित्यं दर्शितम् । तस्मादनेनैव प्रकारेण ग्रहणसदसद्भावेष्टग्रासादिकं[2] सर्वं निर्णीय वक्तव्यमिति[3] ॥ ५७-६३ ॥

इति तन्त्रसंग्रहस्य क्रियाकलापं क्रमेण संगृह्य ।
रचिते तद्व्याख्याने पूर्णोऽभूत् पञ्चमोऽध्यायः ॥

[इति तन्त्रसंग्रहे रविग्रहणप्रकरणं नाम
पञ्चमोऽध्यायः ॥[4]]

व्याख्या—1. A. B. Hapl. om. नेनैवं to नेनैव, next line.

2. A. B. भावेषु ग्रासादिकं

3. A. adds सूचितम्

4. A. actually reads : इति तन्त्रसंग्रहे पञ्चमोऽध्यायः सम्पूर्णः । B. C. omit this colophon.

अथ षष्ठोऽध्यायः

व्यतीपातप्रकरणम्

[व्यतीपातसम्भवः]

अर्केन्द्वोर्हीयते चैका यदान्या वर्धते क्रमात् ।
क्रान्तिज्ययोस्तदा साम्ये व्यतीपातो न चान्यथा ॥ १ ॥

वैधृतोऽयनसाम्ये स्यात् लाटः स्यादेकगोलयोः ॥ २a ॥

[व्यतीपातसम्भवः]

एवं रवीन्द्वोर्ग्रहणद्वयं दृग्गोलविषयं स्पष्टतरं प्रदर्शितम् । इदानीं भगोलविषयं तयोरेव क्रान्तिसाम्यजनितं व्यतीपातं प्रदर्शयितुमाह— [**अर्केन्द्वोरिति** ।]

तत्र **यदार्केन्द्वोरेकतरस्य** इष्टक्रान्तिज्या युग्मपदोद्भूतत्वात् क्रमेण **हीयते,** तदितरस्य ओजपदोद्भूतत्वाद् **वर्धते च,** तत्र तथा क्रमेण क्षीयमाणाया वर्धमानायाश्च क्रान्ते[1]र्यदा मिथः साम्यं[2] स्यात् तदा **व्यतीपातो** नाम दोषः सम्भवति । स पुनरयनान्ततो गोलान्ततश्च तुल्यान्तरितयोरोजयुग्मतया भिन्नपदावस्थितयोरर्केन्द्वोर्बोद्धव्यः । **न** पुनरेकपदावस्थितत्वात् । क्रान्तिज्ययोर्युगपद् वृद्धौ क्षये वा क्रान्तिज्ययोः साम्याभावे[3] वा तस्याभावादिति ।

तत्राप्येकायनगतयोर्गोलभेदे **वैधृताख्यो** व्यतीपातः, **एकगोलगतयो**रयनभेदे लाटाख्यो व्यतीपात इति । उक्तरूपं क्रान्तिसाम्यमेव तयोः सामान्यलक्षणम् । विशेषलक्षणं पुनरयनैक्यं गोलैक्यं चेति ॥ १-२a ॥

व्याख्या—1. C. 1-8·10 क्रान्त्योः 2. C. साम्यः
3. C. 1-8·10 साम्यभावे

[अर्केन्द्वोरिष्टक्रान्तिः]

संस्कृतायनसूर्येन्द्वोः क्रान्तिज्ये पूर्ववन्नयेत् ॥ २b ॥

[चन्द्रस्येष्टक्रान्तौ विशेषः]

पातोनेन्दोर्भुजाजीवा परमक्षेपताडिता ।
त्रिज्याभक्ता विधोः क्षेपः तत्कोटिमपि चानयेत् ॥ ३ ॥

परमापक्रमकोट्या विक्षेपज्यां निहत्य तत्कोट्या ।
इष्टक्रान्तिं चोभे त्रिज्याप्ते योगविरहयोग्ये स्तः ॥ ४ ॥

सदिशोः संयुतिरनयोर्वियुतिर्विदिशोरपक्रमः स्पष्टः ।
स्पष्टापक्रमकोटिर्द्युज्या[1] विक्षेपमण्डले वसताम्[2] ॥ ५ ॥

[अर्केन्द्वोरिष्टक्रान्तिः]

अथार्केन्द्वोरिष्टक्रान्त्यानयनायाह— [संस्कृतायनेति ।]

तत्र सूर्येन्द्वोरिष्टकालसायनस्फुटाद् दोर्ज्यामानीय चतुर्विंशतिभागज्यया निहत्य त्रिज्यया विभज्य[1] लब्धे तयोरिष्टक्रान्तिज्ये स्यातामिति ॥ २b ॥

[चन्द्रस्येष्टक्रान्तौ विशेषः]

तत्र रवेरित्थमानीतैव स्फुटक्रान्तिज्या । चन्द्रस्य पुनर्विक्षेपसंस्कृताया[2] एव[3] स्फुटत्वात् तदानयनायाह— [पातोनेन्दोरिति ।]

तत्र पातहीनात् स्फुटेन्द्वोर्दोर्ज्यां[4] गृहीत्वा परमविक्षेपेण निहत्य त्रिज्यया विभज्य लब्धो विधोरिष्टविक्षेपः । तद्वर्गं त्रिज्यावर्गतो विशोध्य शिष्टस्य[5] मूलं विक्षेपकोटिरिति । अथ परमापक्रमस्य चतुर्विंशतिभागज्यया कोट्या विधोरिष्टविक्षेपज्यां निहत्य तस्येष्टविक्षेपस्य कोट्या तस्येष्टक्रान्तिज्यां च निहत्य तयोर्घातयोः[6] समदिशोर्योगं भिन्नदिशोरन्तरं च कृत्वा

मूलम्— 1. A. B. C_9 द्युज्या   2. C. वसतामिति

व्याख्या—1. C. विभजेत् तत्र   2. C. $_{1-8\cdot10}$ संस्कृतायां

3. C. $_{1-8\cdot10}$ add तस्य   4. C. adds गृहीत्वा

5. A. शेषस्य   6. A. Hapl. om. of घातयोः

इत्युक्तात्र स्फुटा क्रान्तिर्ग्राह्यतां गोलवित्तमैः ॥ ६a ॥

[चन्द्रस्येष्टक्रान्तौ प्रकारान्तरम्]

अथवा क्रान्तिरानेया परक्रान्त्या[1] विधोरपि ॥ ६b ॥

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परमक्षेपकोटिघ्नं जिनभागगुणं हरेत् ।
त्रिज्यया, क्षेपवृत्तस्य[2] नाभ्युच्छ्रय[3] इहाप्यते ॥ ७ ॥

पातस्य सायनस्याथ दोःकोटिज्ये उभे हते ।
क्षिप्त्या परमया त्रिज्याभक्ते स्यातां च तत्फले ॥ ८ ॥

अन्त्यद्युज्याहतं तत्र कोटिजं त्रिज्यया हरेत् ।

त्रिज्यया विभजेत् । तत्र लब्धा विधोरिष्टापक्रमज्या स्फुटा भवति । तस्या वर्गं त्रिज्यावर्गतो विशोध्य शिष्टस्य मूलं **विक्षेपमण्डले वसतां इष्टद्युज्या च** स्यादिति प्रसङ्गादुक्तम् । **इत्युक्त**प्रकारेण समानीतैव **स्फुटक्रान्तिः** दृग्गोलविषये व्यतीपातादौ **गोलवित्तमैर्ग्राह्या**मिति ॥ ४-६a ॥

[चन्द्रस्येष्टक्रान्तौ प्रकारान्तरम्]

अथ प्रकारान्तरेण तस्यैव स्फुटक्रान्त्यानयनायाह— [**अथवा क्रान्तिरिति** ।]

अथवा विधोरिष्टक्रान्तिस्तस्यैव [1]परमक्रान्त्या नीयताम् । यथा[2]—चतुर्विंशतिभागज्यां **परमविक्षेपस्य** व्योमतारा(270′)प्रमितस्य कोट्या निहत्य **त्रिज्यया** विभजेत् । तत्र लब्धः परमविक्षेपव्यासार्ध[3]वृत्तस्य राशिकूटद्वय-प्रतिबद्धसूत्रकेन्द्रस्य **नाभ्युच्छ्रयो** नाम ।

अथ **सायनपातस्य दोःकोटिज्ये उभे** समानीय परमविक्षेपेण निहत्य त्रिज्यया विभजेत् । [4]तत्र लब्धे दोःकोटिफले **स्याताम्** । तयोः **कोटिफलं**

मूलम्— 1. C. $_{1-8}$ स्फुटक्रान्त्या 2. C. $_{1-5,7}$ वृतेऽस्य
3. C. $_{1-6}$ नाड्युच्छ्रय

व्याख्या—1. A. परक्रान्त्या 2. C. तत्प्रकारस्तु for यथा
3. C. व्यासार्धस्य
4. A. B. Hapl. om. from तत्र लब्धे to तत्र, next line.

नाभ्युत्सेधे च तत्स्वर्णं मृगकर्क्यादिपातजम् ॥ ९ ॥

तद्बाहुफलवर्गैक्यमूलं क्रान्तिः परा विधोः ।

त्रिज्याघ्नं दोःफलं भक्तं तया चलनमायनम् ॥ १० ॥

जूकक्रियादिगे पाते स्वर्णं तत् सायने विधौ ।

तद्बाहुज्या हता क्रान्त्या तदा परमया स्वया ॥ ११ ॥

त्रिज्याप्तापक्रमज्येन्दोः स्फुटा तात्कालिकी भवेत् ॥ १२a ॥

[व्यतीपातस्य सदसद्भावः]

संस्कृतक्षेपचलनसायनेन्दो रवेः पदात् ॥ १२b ॥

अन्त्यद्युज्यया निहत्य त्रिज्यया विभजेत् । तत्र लब्धं फलं तत्क्षेपवृत्तस्य नाभ्युच्छ्र्ये पूर्वानीते सायनपातस्य मृगकर्क्यादिवशाद्धनमृणं वा कुर्यात् । एवंकृतस्य तन्नाभ्युच्छ्र्यस्य दोःफलस्य च[1] वर्गयोगमूलं विधोः परमक्रान्तिर्नाम ।

ततः पूर्वानीतं दोःफलं त्रिज्यया निहत्य[2] तया परमक्रान्त्या विभजेत् । तत्र लब्धं विधोरयनचलनं नाम । तत्पुनर्विक्षेपेणानीतत्वात् विक्षेपचलनमिति चोच्यते । तदिदं सायनपातस्य जूकक्रियादिवशात् सायनचन्द्रे धनमृणं च कर्तव्यम् । [3]ततः प्रागुक्तेनेदमानीतेन चायनचलनेन संस्कृतात् [4]स्फुटेन्दोर्दोर्ज्यामानीय तदानीं नीतया[5] स्वया परमक्रान्त्या निहत्य त्रिज्यया विभजेत् । तत्र लब्धा चन्द्रस्येष्टक्रान्तिः स्फुटा स्यादिति ॥ ६-१२a ॥

[व्यतीपातस्य सदसद्भावः]

एवं [6]रवीन्द्वोरिष्टक्रान्त्यानयनं प्रदर्श्य इदानीं तयोः साम्ये व्यतीपातसदसद्भावनियमं दर्शयति — [संस्कृतक्षेपचलनेति ।]

मूलम् — 1. C. पक्रमज्येन्द्वोः

व्याख्या — 1. C. कृतस्य नाभ्युच्छ्र्यस्य तद्दोःफलस्य च

2. A. om. निहत्य

3. C_{1-9} अथ तत्संस्कृतात्

4. C. सायनेन्द्वोः

5. C. तदानीमानीतया

6. B. रवीन्दोरिष्ट; C. रवेरिन्दोरपि इष्ट

ओजयुग्मतया भेदे व्यतीपातो, न चान्यथा ॥ १३a ॥

[व्यतीपाताभावस्थानम्]

अर्केन्द्वोः परमक्रान्त्योरल्पा त्रिज्याहतान्यया ॥ १३b ॥
भक्ता, ततोऽधिके बाहौ महाक्रान्तेर्न तुल्यता[1] ।
तच्चापं भत्रयाच्छोध्यं तदाढ्यो नायनान्तयोः[2] ॥ १४ ॥
अन्तरालं गते तस्मिन् क्रान्त्योः साम्यं न जायते ॥ १५a ॥

उक्तरूपेण विक्षेपचलनेन अयनचलनेन च संस्कृतस्फुटेन्दुर्यदा सायनार्कादोजयुग्मतया भिन्नपदोऽवतिष्ठते, तत्रैव क्रान्तिसाम्ये व्यतीपातो भवति । न पुनरन्यत्रापीति । अतएव उक्तं—

क्रान्तिसाम्ये व्यतीपातो भवेद् भिन्नपदस्थयोः ।
नाभिन्नपदयोरर्कचन्द्रयोर्नाप्यतुल्ययोः ॥

इति ॥ १२b-१३a ॥

[व्यतीपाताभावस्थानम्]

एवं भिन्नपदावस्थितयोरर्कचन्द्रयोः क्रान्तिसाम्याद् व्यतीपातं प्रदर्श्य 'न चान्यथा' इति दर्शितं तदभावस्थानं विवरीतुमाह— [अर्केन्द्वोरिति ।]

अर्केन्द्वोः परमक्रान्त्योरल्पीयसीं परमक्रान्तिं त्रिज्यया निहत्य महत्या परमक्रान्त्या विभजेत् । तत्र लब्धफलात्[1] महापरम[2]क्रान्तिसम्बन्धिन्यां दोर्ज्यायामधिकायां सत्यां इष्टक्रान्त्योस्तुल्यता न स्यात् । तत् पुनः कियदवधिकमिति चेत् तथानीतं फलं चापीकृत्य राशित्रयाद्विशोध्य [3]यच्छिष्यते तद् द्वयोरयनान्तयो[4] राशित्रयराशिनवात्मकयोः पृथक् प्रत्येकं[5] प्रक्षिपेद् विशोधयेच्च । [6]ततस्तथाकृतयोस्तयोरन्तरालंगते तस्मिन् अल्पेतरपरमक्रान्तौ सति क्रान्त्योः साम्यं नैव सम्भवति । तस्येष्टक्रान्तेस्तदितरपरक्रान्तितोऽप्यधिकत्वादिति ॥ १३b-१५a ॥

मूलम्— 1. C. तुल्यया 2. B. $C_{1-8\cdot10}$ नायनं तयोः

व्याख्या—1. C. फलतो 2. C. om. परम
3. $C_{1-8\cdot10}$ शिष्टं द्वयो 4. C. द्वयोरप्ययनान्तयो
5. C. om. प्रत्येकं 6. C. om. ततः

[व्यतीपातसद्भावस्थानम्]

दोर्ज्यां रवेः परक्रान्त्या[1] हत्वा चान्द्र्या तया हरेत् ॥ १५b ॥
लब्धचापसमे चन्द्रबाहौ क्रान्तिगुणौ समौ ।
चन्द्रस्यौजपदस्थस्य दोर्धनुष्यधिके ततः ॥ १६ ॥
व्यतीपातो गतो, न्यूने भावी, युग्मपदेऽन्यथा ।
तदिष्टचन्द्रधनुषो स्वस्वभुक्तिघ्नमन्तरम् ॥ १७ ॥
गतियोगहृतं स्वर्णं दोषे गम्ये गतेऽपि च ।
सूर्येन्द्वोरन्यथा पाते तावत् कुर्यादिदं मुहुः ॥ १८ ॥

[व्यतीपातसद्भावस्थानम्]

यद्येवं क्वैतत्[1] सम्भवतीत्याह— [दोर्ज्यां रवेरिति ।]

सायनरवेर्दोर्ज्यां स्वकीयपरमापक्रमेण निहत्य चान्द्र्या परमक्रान्त्या[2] विभजेत् । तत्र लब्धस्य चापेन तुल्ये तत्कालचन्द्रस्य बाहुचापे सति चन्द्रार्कयोरुक्तवदानीतौ क्रान्तिगुणौ तुल्यौ स्याताम् । अतस्तत्रैव व्यतीपातोऽपि भवति इत्यर्थः[3] । यदा पुनरोजपदावस्थितस्य चन्द्रस्य भुजाचापमिदानीमानीतफलादधिकं स्यात् तदा व्यतीपातो गतोऽतिक्रान्तः स्यात्[4] । ऊने पुनः तस्मिन् भावी व्यतीपातः । युग्मपदावस्थिते[5] चन्द्रे विपरीतं, स्वभुजाचापेधिके[6] भावी, न्यूने[7] गत इति ।

तस्मादेवमानीतफलचापस्य तदानीमयनचलनद्वितयसंस्कृतचन्द्रचापस्य[8] चान्तरं पृथग् अर्कचन्द्रयोर्गतिकलाभिर्निहत्य तयोर्गतियोगकलाभिर्विभजेत् । तत्र लब्धफलं[9] व्यतीपातस्य गतगन्तव्यत्ववशात् सूर्येन्द्वोः ऋणं धनं च कुर्यात् । पाते त्वन्यथा, विलोमगतित्वात् तस्य । इदं कर्म तावत् कुर्याद्

मूलम्— 1. B. परमक्रान्त्या

व्याख्या—1. C. क्व पुनरेतत्
2. A. चन्द्रपरमक्रान्त्या
3. C. om. इत्यर्थः
4. C. गतः भूत इत्यर्थः
5. C. adds पुनः
6. $C_{1-6\cdot 8}$ चापाधिकः
7. C. ऊने
8. C_{1-8} चलनमितस्य संस्कृत; C_{9-10} चलनद्वितयस्य संस्कृ..
9. C. लब्धं फलं

यावदर्कोत्थधनुषा तत्कालेन्दुधनुः समम् ॥ १९a ॥

[व्यतीपातमध्यः]

क्रान्तिसाम्ये व्यतीपातमध्यकालः सुदारुणः[1] ॥ १९b ॥

यावदर्कदोर्ज्योत्पन्नचन्द्रधनुषा तत्कालेन्दुधनुषस्तुल्यत्वं स्यात्[1] । तदर्थं एवं-कृतादर्कात् पुनरपि दोर्ज्यामानीय स्वकीयपरमक्रान्त्या निहत्य चान्द्रया परमक्रान्त्या विभज्य लब्धस्य यच्चापं [2]तस्य सकृत्संस्कृततत्फलप्रागानीतायनचलनद्वितयसंस्कृतचन्द्रभुजाचापस्य चान्तरं कलीकृत्य[3] स्वस्वगतिकलाभिर्निहत्यार्केन्द्वोर्गतियोगकलाभिर्विभजेत् । तत्र लब्धं फलमपि प्राचीनेषु तत्संस्कृततत्फलेषु चन्द्रार्कपातेषु पूर्ववत्[4] कुर्यात् । एवं तावद्यावदर्कोत्थेन्दुचापेन तत्कालचन्द्रचापं तुल्यं भवेत् । तत्र क्रान्त्योस्साम्योपलम्भाद् व्यतीपातोऽपि विज्ञेय इति ॥ १५b-१९a ॥

[व्यतीपातमध्यः]

कथं[5] क्रान्तिसाम्येन तत्परिज्ञानमित्यत आह— [क्रान्तिसाम्येति ।]

इत्थमानीतयोः क्रान्तिज्ययोस्तुल्यत्वे व्यतीपातस्य मध्यकालो विज्ञातव्यः । मध्यकाल इत्यनेन तत्पूर्वापरकालानुबन्धितया कियन्तश्चित्[6]कालमवस्थानं सूचितम् । यदुक्तं सूर्यसिद्धान्ते—

आद्यन्तकालयोर्मध्ये व्यतीपातोऽतिदारुणः[7] ।
प्रज्वलज्ज्वलनाकारः सर्वकर्मबहिष्कृतः ॥

इति ।

यथा[8]—

बिम्बनेम्योर्बहिर्भावः [9]तयोस्तत्सूत्रतो यदा ।
तावत्कालं विजानीयाद् व्यतीपातमवस्थितम् ॥

इति ॥ १९b ॥

मूलम्— 1. A. B. स दारुणः

व्याख्या—1. $C_{1-8\cdot10}$ तत्कालेन्दोर्भुजाधनुः समं भवति

2. C. तस्य प्राचीनायनचलन
3. C. च विश्लेषकला।
4. C. प्राग्वत्
5. A. अथ कथं
6. C. किञ्चित्
7. C. पातः सुदारुणः
8. C. तथा
9. C. om. तयोः

[व्यतीपातप्रारम्भः पर्यवसानं च]

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नवांशपञ्चकं तत्त्वभागौ बिम्बौ स्वभुक्तितः ।
सूर्येन्द्वोर्बिम्बसम्पर्कदलं षष्ट्या निहत्य यत् ॥ २० ॥

गतियोगोद्धृतं तद्धि व्यतीपातदलं विदुः ।
व्यतीपातदले तस्मिन् नाडिकादौ विशोधिते ॥ २१ ॥

मध्यकालाद् भवेत् तस्य प्रारम्भसमयः स्फुटः[1] ।
तद्युते मध्यकालेऽस्य मोक्षो वाच्यो हि धीमता ॥ २२ ॥

[व्यतीपातप्रारम्भः पर्यवसानं च]

अथ अर्केन्द्वोर्भगोलगतलिप्ताव्यासाभ्यां व्यतीपातदलानयनपुरस्सरं तस्यैव प्रारम्भपर्यवसानकालौ दर्शयति— [**नवांशेति** ।]

तत्र तावद् रवेः स्फुटभुक्तिकलाः पञ्चभिर्निहत्य नवभिर्विभजेत् । तत्र लब्धास्तस्यैव बिम्बकला । भवन्ति । इन्दोः पुनः [1]गतिकलाभ्यः पञ्चविंशत्या विभज्य लब्धा बिम्बफलाः । तथानीतयोस्तद्बिम्बयोः सम्पर्कदलं **षष्ट्या निहत्य** तयोर्गतियोगेन विभजेत् । तत्र लब्धं नाडिकादिकं[2] **व्यतीपातदलं** नाम । तेन द्विगुणितेन तुल्यो व्यतीपातस्य कृत्स्नः[3] कालः । **तस्मिन् व्यतीपातदले** तन्मध्यकालतो[4] **विशोधिते** तस्य **प्रारम्भसमयः स्फुटो** भवति । पुनस्तेनैव संयुक्ते तस्मिन् **मोक्षो**ऽपि **वाच्यः** । **धीमते**त्यनेनैवमेव व्यतीपातविज्ञानं[5] युक्ततममिति दर्शितम्[6] ॥ २०-२२ ॥

मूलम्— 1. समयस्फुटः

व्याख्या—1. C. स्फुटगति 2. B. लब्धनाडिकादिकं

3. B. कृत्स्नं

4. B. मध्यकाले 5. C. व्यतीपातकालविज्ञानं

6. C. adds : **बिम्बौ स्वभुक्तितः** इत्यत्र स्फुटभुक्तिर्विवक्षिता । **गतियोगोद्धृतं** तद्धीत्यत्र गतियोगशब्देन क्रान्तिगतियोगो विवक्षित इति युक्तिवशात् सिध्यति । सूर्यस्य पूर्वापरदिनोत्थयोः क्रान्तिचापयोर्यदन्तरं तदत्र सूर्यगतिर्भवति । चन्द्रस्य पूर्वापरदिनोत्थयोः क्रान्तिचापयोर्यदन्तरं तदत्र चन्द्रगतिर्भवति । तयोर्योगोऽत्र **गतियोग** इत्युच्यते ।

[विष्कम्भादियोगान्त्यार्धानां त्याज्यत्वम्]

विष्कम्भादिषु योगेषु व्यतीपाताह्वयोऽपि यः ।
तस्य सप्तदशस्यान्त्यमर्धं चाप्यतिदारुणम् ॥ २३ ॥

[व्यतीपातत्रयाणां त्याज्यत्वम्]

व्यतीपातत्रयं घोरं सर्वकर्मसु गर्हितम् ।
स्नानदानजपश्राद्धव्रतहोमादिकर्मसु ।
प्राप्यते सुमहच्छ्रेयः तत्कालज्ञानतस्ततः ॥ २४ ॥

[इति तन्त्रसंग्रहे व्यतीपातप्रकरणम् नाम
षष्ठोऽध्यायः ॥]

[विष्कम्भादियोगान्त्यार्धानां त्याज्यत्वम्]

न केवलमनयोरेव लाटवैधृतयोः स्वयं व्यतीपतनात्[1] तज्जनकत्वाद्वा दारुणतरत्वं,[2] अपि तु विष्कम्भादिषु, [3]सप्तदशयोगस्यान्त्यार्धस्यापीत्याह— [**विष्कम्भादिष्विति ।**] यदुक्तम्[4]—

सूर्येन्दुयोगे मैत्रस्य परार्धं सम्भवेद् यदि ।
सार्पमस्तकसंज्ञः स्यात् तदा दोषोऽतिनिन्दितः ॥

इति ॥ २३ ॥

[लाट-वैधृत-सार्पमस्तकानां त्याज्यत्वम्]

उक्तरूपं व्यतीपातत्रयं सर्वकर्मसु त्याज्यमेवेत्याह—[**व्यतीपातत्रयेति ।**]

एतद् **व्यतीपातत्रयं** घोररूपं यतस्ततः तस्मिन् यदि **स्नानदानादिकं** क्रियेत तदा अतिमहद् **श्रेयः** प्राप्येतापीति[5] ॥ २४ ॥

इति तन्त्रसंग्रहस्य क्रियाकलापं क्रमेण संगृह्य ।
रचिते तद्व्याख्याने षष्ठोऽध्यायः प्रपूर्णोऽभूत् ॥

॥ इति तन्त्रसंग्रहे सव्याख्याने षष्ठोऽध्यायः[6] ॥

व्याख्या—1. C. पातमात्　　2. C. जनकत्वादुरुतरत्वम्
3. B. C. सप्तदशस्य योगस्य　　4. C. तदुक्तं
5. C. reads : उक्तरूपं लाटवैधृतसार्पमस्तकाख्यं **व्यतीपातत्रय**मेतद् **घोर-रूपं** यतः, अतः **सर्वकर्मसु गर्हित**मेव । यदि पुनस्तस्मिन् **स्नानदानजपश्राद्ध-व्रतहोमादिकर्म** क्रियेत तत् **सुमहच्** **श्रेयः** **प्राप्येत** इति ।
6. B. C. om. this colophon.

अथ सप्तमोऽध्यायः

दृक्कर्मप्रकरणम्

[दृक्कर्मद्वयम्—आक्षं आयनं च]

विषुवद्भाघ्नविक्षेपाद् द्वादशाप्तं विधोः स्फुटात् ।
उदये सौम्यविक्षेपे शोध्यमस्तमये धनम् ॥ १ ॥

व्यस्तं तद् याम्यविक्षेपे, न मध्यस्थे विधाविदम् ।
सत्रिभग्रहजक्रान्तिभागघ्नाः क्षेपलिप्तकाः ॥ २ ॥

विकलाः स्वमृणं क्रान्तिक्षेपयोर्भिन्नतुल्ययोः ।
एवंकृतो ग्रहो लग्नं स्वोदये भवति स्फुटम् ॥ ३ ॥

[दृक्कर्मद्वयम्—आक्षं आयनं च]

एवं व्यतीपातस्वरूपं विस्तरतः प्रदर्शितम् । इदानीं चन्द्रादीनामर्कतो विप्रकर्षवशाद् दृश्यादृश्यविभागस्य दृक्कर्मद्वयसापेक्षत्वात् तत्प्रदर्शनायाह—
[विषुवद्भेति ।]

तत्र चन्द्रस्य विक्षेपानयनं पूर्वमेव प्रदर्शितम्—

पातोनेन्दोर्भुजाजीवा[1] व्योमताराहता हृता ।
त्रिज्यया सौम्ययाम्येन्दोः ॥

(तन्त्रसंग्रहः, ४.२७a-२८a)

इति ।

ततश्चन्द्रस्येष्टविक्षेपं स्वदेशविषुवच्छायाङ्गुलैर्निहत्य द्वादशभिर्विभजेत् । तत्र लब्धमुदये सौम्यविक्षेपे सायनात् स्फुटेन्दोर्विशोधयेत्, अस्तमये पुनस्तस्मिन् प्रक्षिपेत् । याम्यविक्षेपे पुनस्तद् व्यस्तम् उदये सायनस्फुटेन्दौ प्रक्षिपेत्, अस्तमये ततो विशोधयेदिति । खमध्यस्थे विधौ पुनः इदं कर्म न[2] कर्तव्यम् । एतदाक्षं दृक्कर्मेति ।

व्याख्या—1. A. om. जीवा 2. A. B. $C_{1-8\cdot10}$ om. न

स्वास्तेऽस्तलग्नमेवं स्यान्मध्यलग्नं खमध्यगे ॥ ४a ॥

[ग्रहाणां इष्टविक्षेपः]

मन्दस्फुटात् स्वपातोनात् भौमादीनां भुजागुणात् ॥ ४b ॥

परमक्षेपनिघ्ना स्यात् क्षेपोऽन्त्यश्रवणोद्धृतः ।

4　2　8　6　10　10

कृत-नेत्र-भुजङ्गा-ङ्गा दिशो दश-गुणाः क्रमात् ॥ ५ ॥

अथ राशित्रयसहितात् तत्कालसायनेन्दोः [1]क्रान्तिचापमानीय ततः षष्ट्या विभज्य लब्धाः क्रान्तिभागाः । तद्गुणिता इष्टविक्षेपकला एव दर्शनसंस्कारविकलाः । ताश्च राशित्रयसहितग्रहक्रान्तेः[2] केवलोत्पन्नविक्षेपस्य च गोलभेदे ग्रहे प्रक्षिपेत् । तुल्यगोलत्वे ततो विशोधयेत् । एतदायनं दृक्कर्म इति ।

[3]तद्दृक्कर्मफलद्वयसंस्कृतो ग्रहः तदानीमुदयलग्नं, **स्वास्ते** पुन-**रस्तलग्नं, खमध्यगे मध्यलग्नम्** । [4]किन्तु मध्यलग्नेऽस्मिन् आयनमेव दृक्कर्मफलं कर्तव्यम् । न पुनराक्षमपोति ॥ १-४a ॥

[ग्रहाणां इष्टविक्षेपः]

अथ कुजादीनामिष्टविक्षेपानयनायाह— [**मन्दस्फुटादिति** ।]

तत्र **भौमादीनां** पञ्चानां **स्वमन्दस्फुटतः** पातभागान् विशोध्य शिष्टतो गोलद्वयमवधार्य दोर्ज्यामानीय परमविक्षेपकलाभिर्निहत्य अन्त्यश्रवणेन शीघ्र[5]कर्णेन विभजेत् । तत्र लब्ध इष्टविक्षेपः । अत्र मन्दस्फुट-शब्देन कृत्स्नमन्दफलसंस्कृतस्फुटमध्यम उच्यते । शीघ्रकर्णश्चान्त्यस्फुट-कर्मण्यानीतः । अत एवोक्तं **अन्त्यश्रवणोद्धृत** इति । भौमादीनां पञ्चानां **पातभागाः कृत-नेत्र-भुजङ्गा-ङ्ग-दिशो दश-गुणिताः** । तत्र[6] कुजस्य चत्वारिंशद् भागाः । बुधस्य विंशतिः । गुरोरशीतिः । शुक्रस्य षष्टिः । मन्दस्य

व्याख्या—1. B. क्रियाचाप　2. C_{10} क्रान्तौ
3. C. om. तद्　4. C. कृतमध्यलग्ने
5. C. स्वशीघ्र　6. C. om. तत्र

पातभागाः कुजादीनाम्, अथ विक्षेपलिप्तिकाः ।
9 12 6 12 12 10
नवा-र्क-र्त्व-र्क-रवयो दशघ्नाः परमाः क्रमात् ॥ ६ ॥

[ग्रहाणां दृक्कर्म]

विक्षेपाच्छशिवत् कार्ये तेषां दृक्कर्मणी उभे ॥ ७ ॥

[दृक्कर्मणि प्रकारान्तरम्]

विक्षेपदृक्क्षेपवधे त्रिमौर्व्या निहत्य तत्कोटिवधेन भक्ते ।
धनुर्धनर्णं हरिदैक्यभेदात् तयोः शशाङ्काद्युदये[1]ऽन्यथास्ते ॥ ८ ॥

शतमिति । तेषां परमविक्षेपलिप्ताः नवा-र्क-र्त्व-र्क-रवयो दश-गुणिताः । तत्र कुजस्य नवतिः । बुधस्य विंशत्यधिकं शतम् । गुरोः षष्टिः । शुक्रशनैश्चरयो-र्विंशत्यधिकं शतमिति । अत्र विक्षेपस्वरूपं प्रति यद्वक्तव्यं तन्मयैव एतद्व्याख्यायां युक्तिदीपिकायां प्रपञ्चितमिति तत एवावधार्यम् ॥ ४b-६ ॥

[ग्रहाणां दृक्कर्म]

अथ तेषामपि इष्टविक्षेपतो दृक्कर्मयुगलं शशिवदेव कर्तव्यमित्याह—
[विक्षेपादिति ।]

कुजादीनां मन्दस्फुटादानीतं इष्टविक्षेपं विषुवच्छायाङ्गुलैर्निहत्य द्वादशभिर्विभज्य लब्धं आक्षं दृक्कर्मफलं सौम्यविक्षेपे ग्रहस्योदये ततः शोध्यं, अस्तमये क्षेप्यम् । याम्यविक्षेपे विपरीतम् । अथ सायनस्फुटग्रहाद् राशित्रयसहिताद् भुजायाः क्रान्तिभागानानीय तद्गुणिता विक्षेपकला एवायनं दृक्कर्मफलं विकलात्मकम् । तत् सत्रिभग्रहस्य विक्षेपस्य च गोलभेदे धनं, गोलसाम्ये तु ऋणम् । एवंकृतो ग्रहः स्वोदये उदयलग्नं, अस्तमये चास्तलग्नम् । खमध्यगे पुनरायनेनैव दृक्कर्मणा संस्कृतस्फुटग्रहो मध्य-लग्नमिति ॥ ७ ॥

[दृक्कर्मणि प्रकारान्तरम्]

अथ दृक्कर्मण्येव प्रकारान्तरमाह[1]— [विक्षेपेति ।]

मूलम्—1. C. उदयो (wr.)

व्याख्या—1. C. दर्शयति for आह

एवं वा युगपत् कार्यं दृक्कर्मयुगलं स्फुटम् ॥ ९ ॥

[काललग्नम्, कालभागाश्च]

एवंकृतस्य चन्द्रादेः स्वोदयेऽस्तमयेऽपि वा ।
सायनस्य रवेश्चापि काललग्नं नयेद् द्वयोः ॥ १० ॥

तत्रोदयास्तमययोः सायनस्फुटग्रहस्य यो विक्षेपः, यश्च तदानीं काललग्नकोट्याः समानीतो दृक्क्षेपः, तयोः संवर्गात्[1] त्रिज्यया निहतात्[2] तयोर्विक्षेपदृक्क्षेपयोः [3]कोट्योर्घातेन विभजेत् । तत्र लब्धस्य यच्चापं तद्विक्षेपदृक्क्षेपयोस्तुल्यदिक्कत्वे सायनस्फुटग्रहे धनं कुर्यात्, भिन्नदिक्कत्वे पुनः ऋणं कुर्यात् । अस्तमये पुनरन्यथा, दिग्भेदे धनं दिक्साम्ये पुनः ऋणं इति । एवं[4]क्रियमाणमेव आक्षायनं दृक्कर्मयुगलं स्फुटमिति । अत्र दृक्फलसिद्धादेव [5]स्फुटग्रहाद् दृक्क्षेपानयनमुचितम् । तत एव च दृक्फलमित्यन्योन्याश्रयत्वात् अविशेषकर्मणैव स्फुटत्वं स्यादिति । तदुक्तम्—

स्यादेतद्यदि दृक्क्षेपस्सिद्धस्तात्कालिको भवेत् ।
नहि कालान्तरोत्पन्नः स लग्नापादनक्षमः ॥
[6]लग्नाधीनः स दृक्क्षेपस्तदधीनं च[7] दृक्फलम् ।
इत्यन्योन्याश्रयत्वं तदविशेषान्निरस्यते ॥

इति ॥ ८-९ ॥

[काललग्नम्, कालभागाश्च]

अथ दृक्कर्मयुगलसिद्धस्य ग्रहस्यार्कस्य च काललग्नानयनपूर्वकं दर्शनहेतून् तदन्तरालकालभागानुपदिशति— [एवंकृतस्येति ।]

उक्तवद् दृक्कर्मयुगलसंस्कृतस्य सायनस्फुटग्रहस्य उदयेऽस्तमये वा लग्नतां नीतस्य सायनार्कस्य च काललग्नमानयेत् । तत् पुनरुदयास्तलग्नयोश्चरप्राणकालान्तरसंस्कारादेव भवति । तयोः काललग्नयोरन्तरालोत्पन्नैर्द्वादशादिभिः कालभागैर्ग्रहा दृश्या भवन्ति । ततो न्यूनैर्न द्रष्टुं शक्यन्ते,

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व्याख्या—1. C. सम्पर्कं
2. C. 8-10 निहृत्य 3. C. कोट्या
4. C. adds युगपत्‌ 5. C. स्फुटदृक्क्षेप
6. C. लग्नादीनसदृक्क्षेप 7. A. तदधीनश्च

तदन्तरभवैर्भागैः[1] दृश्यः स्याद् द्वादशादिभिः ।
न्यूनैः खेटो न दृश्यः स्याद् भानुरश्मिहतप्रभः ॥ ११ ॥

12 17 13 11 9 15
द्वादशा-त्यष्टयो विश्वे रुद्रा-ङ्क-तिथयः क्रमात् ।
चन्द्रादिकालभागास्तैर्दृश्या स्वार्कान्तरोद्भवैः ॥ १२ ॥

[ग्रहाणां उदयास्तमयदृश्यादृश्यता]

अस्तं यान्तीड्यशन्याराः पश्चात् प्रागुदयन्ति च ।
ज्ञशुक्रौ वक्रिणावेवमन्यथा शीघ्रगा रवेः ॥ १३ ॥

पश्चाच्चेद् षड्भयुक्तार्कग्रहयोरन्तरोद्भवैः ।
कालभागैरिह ज्ञेयं दृश्यत्वं वाप्यदर्शनम् ॥ १४ ॥

भानुरश्मिभिर्हतप्रभत्वात् । अधिकैः पुनः सुतरां द्रष्टुं शक्या इति । तत्र दृक्कर्मयुगलसंस्कृतश्चन्द्रः स्वस्यार्कस्य च काललग्नीकृतयोरन्तरालोत्पन्नैर्द्वादशभिर्भागैर्दृश्यो भवति । कुजः पुनरत्यष्टिभिः सप्तदशभिः,[1] बुधो विश्वैस्त्रयोदशभिः, जीवो रुद्रैरेकादशभिः, शुक्रोऽङ्कैर्नवभिः, मन्दस्तिथिभिः पञ्चदशभिः इति ॥ १०-१२ ॥

[ग्रहाणां उदयास्तमयदृश्यादृश्यता]

अथ ग्रहाणामुदयास्तमययोर्दृक्फल[2]संस्कारार्थं तद्विभागं दर्शयति—
[अस्तमिति ।]

अत्र ग्रहाणां रविबिम्बप्रवेशः ततो निर्गमश्चोदयास्तमयशब्दाभ्यामुच्यते । न पुनः प्राक्पश्चात् क्षितिजसंस्पर्शाविति । ततोऽर्कान्मन्दगतयः शनिगुरुकुजाः पश्चात् पश्चिमदिश्येवास्तं गच्छन्ति, प्राग्दिशि चोदयं गच्छन्ति । वक्रिणौ बुधशुक्रावप्येवमेव । अर्कतः शीघ्रगतयः पुनः क्रमगती बुधशुक्रौ चन्द्रश्च, अन्यथा पश्चादुदयं यान्ति, प्राग्दिश्यस्तं यान्ति च । तत्र प्राग्दिशि यथोक्तमेव । काललग्नीकृतयोर्ग्रहार्कयोरन्तरालोत्पन्नैः कालभागैः दृश्यादृश्यविभागः परिकल्पयितव्यः । पश्चिमदिशि पुनः षड्भयुक्तयोरेव ग्रहार्कयोरिति विभागः इति ॥ १३-१४ ॥

मूलम्—1. C, कालैः for भागैः

व्याख्या—1. A. om. सप्तदशभिः 2. C. दृक्कर्मफल

स्वारूढभांशलिप्ताद्यैः स्वस्वविक्षेपतोऽपि च ।

ज्योतिषामितरेषां च कालांशैर्नीयते स्वकैः ।

दर्शनादर्शने वाच्ये सम्यगेव परीक्षकैः ॥ १५ ॥

[इति तन्त्रसंग्रहे दृक्कर्मप्रकरणं नाम

सप्तमोऽध्यायः ॥]

एवमितरेषामपि ज्योतिषां दर्शनादर्शनविभाग इत्याह— [**स्वारूढेति ।**]

तत्र *यथा* चन्द्रादीनां भगोलावस्थितिरनियता,[1] तास्वारूढराश्यंशस्य विक्षेपस्य च प्रतिक्षणं विभिन्नत्वात् । न त्वेवमन्येषां **ज्योतिषां** सदैवाऽस्थिरत्वान्नियतरूपत्वादुभयोरिति । ततस्तेषामपि तद्द्वितयावगमपूर्वकं उक्तन्यायेन दृक्फलद्वयमानीय तत्संस्कृतस्य तस्यैव ज्योतिषः सायनार्कस्य च द्वयोः काललग्नानयनपूर्वकं नियतैस्तदन्तरालोत्पन्नैः कालभागैः **दर्शनादर्शने** वक्तव्ये इति । अत्र ज्योतिषां स्वबिम्बमहत्त्वाल्पवशात् कालांशनियम इति ॥ १५ ॥

इति तन्त्रसंग्रहस्य क्रियाकलापं क्रमेण संगृह्य ।

रचिते तद्व्याख्याने पूर्णोऽभूत् सप्तमोऽध्यायः ॥

॥ इति तन्त्रसंग्रहे सव्याख्याने

सप्तमोऽध्यायः[2] ॥

व्याख्या—1. C. स्थितीरानीय (wr.)

2. A. adds : समाप्तः । शम् । B. C. om. the colophon.

अथ अष्टमोऽध्यायः

शृङ्गोन्नतिप्रकरणम्

[चन्द्रस्य द्वितीयस्फुटः]

व्यर्केन्दुबाहुकोटिज्ये हतेऽपीन्दूच्चभास्वतः ।
कोट्यर्धेन त्रिजीवाप्तदशघ्नेन्दुकलाश्रुतौ ॥ १ ॥

अयनैक्ये च भेदे च स्वर्णं कोटिजमेतयोः ।
तद्बाहुफलवर्गैक्यमूलमिन्दुधरान्तरम् ॥ २ ॥

[चन्द्रस्य द्वितीयस्फुटः]

एवं ग्रहाणां भगोलविषयं दृक्कर्मयुगलं स्फुटतरं प्रदर्शितम् । इदानीं चन्द्रस्यैव सितमानशृङ्गोन्नत्यादिकं प्रदर्शयितुमाह— [**व्यर्केन्दुबाहुरिति ।**]

तत्र [1]स्फुटार्कोनस्फुटेन्दोः दोःकोटिज्ये उभे समानीय चन्द्रोच्चविरहित-स्फुटार्ककोटिज्यार्धेन निहत्य त्रिज्यया विभजेत् । तत्र लब्धे दोःकोटिफले स्याताम् । तत्र कोटिफलं दशगुणिते चन्द्रस्फुटकलाकर्णे कुर्यात् । स्फुटार्कोन-स्फुटचन्द्रस्य चन्द्रोच्चोनस्फुटार्कस्य च अयनैक्ये धनं कुर्यात् । अयनभेदे पुनः ऋणं कुर्यात् । एवं तत्कोटिफलसंस्कृतस्य दशगुणितचन्द्रमन्दस्फुटकर्णस्य तद्बाहुफलस्य च वर्गयोगमूलं इन्दुधरयोरन्तरं योजनात्मकं द्वितीयस्फुटकर्ण इत्यर्थः ।

ततो बाहुफलं त्रिज्यया निहत्य तेन कर्णेन विभजेत् । तत्र लब्धं विधोः स्फुटे कुर्यात् । तद्यथा—शुक्लपक्षे चन्द्रोच्चोनस्फुटार्के कर्क्यादिगते विधु-स्फुटे धनं कुर्यात्, शुक्लस्य एव चन्द्रोच्चोनस्फुटार्के मृगादिगते[2] पुनस्तस्मिन्नेव विधुस्फुटे ऋणं कुर्यात् । असिते कृष्णपक्षे पुनरन्यथा । कर्क्यादावृणं, मृगादौ[3] धनं कुर्यादित्यर्थः । एवं द्वितीयस्फुटीकरणसिद्धो विधुर्भवति ॥ १-३ ॥

व्याख्या—1. B. Hapl. om. : स्फुटा to स्फुटा, next line.

2. C_{10} मेषादिगते 3. C_{10}. मकरादौ

त्रिज्याघ्नं बाहुजं तेन भक्तं स्वर्णं विधोः स्फुटे ।
कक्र्यैणादौ विधूच्चोनरवौ शुक्लेऽन्यथाऽसिते ॥ ३ ॥

मध्यभुक्तिर्दशघ्नेन्दोस्त्रिज्याघ्ना योजनैर्हृता ।
भूचन्द्रान्तरगैर्भुक्तिर्विधोरस्य स्फुटा मता ॥ ४ ॥

ग्राह्योऽयमेव भूस्थानां द्रष्टॄणां चन्द्रमाः सदा ।
तिथिनक्षत्रयोगादौ लाटे चान्यो भगोलगः ॥ ५ ॥

[विक्षेपः नतिश्च]

पातं विशोध्य चान्यस्माद् व्यतीपातोक्तवर्त्मना ।
आनीतमिष्टविक्षेपं योजनश्रुतिताडितम् ॥ ६ ॥

अथ तत्रैव स्फुटभुक्तेरानयनमाह— [मध्यभुक्तिरिति ।]

चन्द्रस्य मध्यभुक्तिकला दशभिस्त्रिज्यया च निहत्य भूचन्द्रान्तरगैर्योजनैः द्वितीयस्फुटकर्णाख्यैरिदानीमानीतैर्विभजेत् । तत्र लब्धा चन्द्रस्य द्वितीयस्फुट-भुक्तिर्भवतीति ॥ ४ ॥

द्वितीयस्फुटीकरणस्य विभागमाह[1]— [ग्राह्योऽयमिति ।]

[2]भूपृष्ठावस्थितद्रष्टृदृक्केन्द्रेण ग्रहप्रापिणा[3] प्रतिक्षणमन्यादृशसंस्थानेन दृङ्मण्डलेन यदा ग्रहः परिच्छिद्यते[4] यथा ग्रहणद्वये चन्द्रार्कौ यथा वा शृङ्गोन्नतौ चन्द्रः तत्रोक्तवद्, द्वितीयस्फुटसिद्ध एव, चन्द्रो ग्राह्यः । अन्यत्र तिथिनक्षत्रयोगादौ लाटे च भगोलगत एव । प्रथमस्फुटसिद्ध एवेत्यर्थः ॥ ५ ॥

[विक्षेपः नतिश्च]

अथ विक्षेपानयनायाह— [पातं विशोध्येति ।]

व्याख्या—1. C_{1-9}. विषयं दर्शयति

2. B. Hapl. om. of भूपृष्ठ to भगोल, 3 lines below.

3. A. ग्रहलाघविना; B. Included in hapl. om. above.

4. $C_{1-6,9}$ विच्छिद्यते

भूचन्द्रान्तरगैर्हत्वा लब्धः क्षेपस्तथैव च ।
रवीन्द्वोः पृथगानीय नतिलम्बनलिप्तिकाः ॥ ७ ॥

तत्र[1] द्वितीयस्फुटं विना अन्यस्मादेव केवलात् स्फुटेन्दोः पातं विशोध्य गोलद्वयमवधार्य दोर्ज्यामानीय परमविक्षेपेण निहत्य त्रिज्यया विभजेत् । तत्र लब्धो विक्षेपो व्यतीपातोक्तवर्त्मनाऽऽनीतः । यदुक्तम्—

पातोनेन्दोर्भुजाजीवा परमक्षेपताडिता ।
त्रिज्याभक्ता विधोः क्षेपः ॥
(तन्त्रसंग्रहः, ६.३)

इति ।

तमिष्टविक्षेपं मन्दयोजनकर्णेन[2] निहत्य द्वितीयस्फुटयोजनकर्णेन विभजेत् । द्वितीयस्फुटकर्णस्यैव भूचन्द्रान्तरयोजनरूपत्वात् । तत्र लब्धो भूगोल-विषय इष्टविक्षेपः । स[3] पुनर्दृग्गोले[4] कर्तव्यः । तच्च प्राग्वदेव । यदुक्तं प्राक्—

विक्षेपः केवलाच्चन्द्रात् प्राग्वत् त्रिज्याहृतो हतः ।
योजनैर्विवरे चन्द्रभगोलघनमध्ययोः ॥
दृक्कर्णयोजनैर्भक्तो दृग्गोले क्षेप इष्यताम् ॥
(तन्त्रसंग्रहः, ५.४४b-४५)

इति ।

तत उक्तवदानीतं विक्षेपं पुनर्द्वितीयस्फुटयोजनकर्णेन निहत्य दृक्कर्णयोजनैर्विभजेत्[5] । अथवा अत्र द्वितीययोजनकर्णेन हरणं पुनस्तेनैव गुणनं च विधाय[6] त्रिज्यया विभज्य लब्धं इष्टविक्षेपं स्फुटयोजनकर्णेन निहत्य दृक्कर्णयोजनैरेव विभजेत् । तत्र लब्धः स्फुटो विक्षेप इति । स च विक्षेप इन्दुनतिसंस्कृतो बिम्बान्तरे नतित्वेन गृह्यते । अर्कस्य पुनर्विक्षेपाभावात् स्वाभाविक्येव नतिरिति । नत्यानयनं प्रागेवोक्तम्—

व्याख्या—1. $C_{1-6\cdot8}$ ततः 2. C. मन्दस्फुटयोजनकर्णेन
3. C. एवमानीतो विक्षेपः for स
4. C. भगोले
5. B. Hapl. om. । विभजेत् to विभजेत् of next sentence.
6. C. चावधूय

प्राग्वद् भूपृष्ठविक्षेपः[1] स चेन्दुनतिसंस्कृतः[2] ।
बिम्बान्तरे नतिर्ग्राह्या विधोरर्कस्य चेत् स्वकाः ॥ ८ ॥

[चन्द्रार्कबिम्बान्तरानयनम्]

कृतलम्बनचन्द्रार्कविवराज्ज्याशरौ नयेत् ।
तज्ज्यामिन्दुनतीषुघ्नां त्रिज्याप्तां गुणतस्त्यजेत् ॥ ९ ॥

केवलादेव दृक्क्षेपाद् भूव्यासार्धेन ताडितात् ।
विधोर्योजनदृक्कर्णभक्तास्त्र नतिलिप्तिकाः ॥
तद्वदेव च दृक्क्षेपात् स्वदृक्कर्णेन भास्वतः ॥

(तन्त्रसंग्रहः, ५.४६-४७a)

इति । तत्र विधोर्नतिविक्षेपयोः तुल्यदिशोर्योगं भिन्नदिशोर्विश्लेषं च कुर्यात् । एवंकृत इन्दुनतिसंस्कृतस्फुटो विक्षेपो भवति । नत्युत्क्रमोऽपि स्फुटनतिचापस्योत्क्रमज्यैव[1] । लम्बनमपि तयोः प्रागेवोक्तम्—

तत्कालचन्द्रदृक्क्षेपलग्नान्तरभुजागुणात् ।
अर्कवद् दृग्गतिः साध्या भूव्यासार्धहते तयोः ॥
दृग्गती स्वस्वदृक्कर्णयोजनैर्विहृते कलाः ।
धनं दृक्क्षेपलग्नात् प्राक् सूर्येन्द्वोर्ऋणमन्यथा ॥

(तन्त्रसंग्रहः, ५.५०-५१)

इति । एतत्सर्वं प्राग्वदित्यनेन सूचितम्[2] । अतएव वक्ष्यति[3]— **कृतलम्बनचन्द्रार्कविवरात्** इति । (तन्त्रसंग्रहः, ८.९) ॥ ८ ॥

[चन्द्रार्कबिम्बान्तरानयनम्]

अथ चन्द्रार्कान्तरे प्रथमपदगते बिम्बान्तरानयनायाह— [**कृतलम्बनेति** ।]

मूलम्— 1. B. C. विक्षेपं 2. C. °संस्कृतम्

व्याख्या— 1. C. adds : नान्यत् किञ्चिदिति ।
2. C. वर्णितम् for सूचितम् 3. C. वक्ष्यते

नतीषुफलकृत्योश्च भेदान्मूलमिषौ क्षिपेत् ।
गुणबाणौ तथाभूतावुच्येते[1] विवरोद्भवौ[2] ॥ १० ॥

विवरोत्थशरस्यार्कनतिबाणस्य चान्तरम् ।
अन्तरज्या च या यच्च नतिज्या विवरं तयोः ॥ ११ ॥

योग एव दिशोर्भेदे नत्योरत्र शशीनयोः ।
त्रयाणां वर्गयोगस्य मूलं बिम्बान्तरं स्फुटम्[3] ॥ १२ ॥

[4]कृतलम्बनचन्द्रार्कविवरे भत्रयाधिके ।
तदन्तरदलस्यैव ज्या ग्राह्या न शरस्तदा ॥ १३ ॥

उक्तवल्लम्बनसंस्कृतयोश्चन्द्रार्कयोर्यदन्तरालचापं ततः क्रमज्यां [1]व्युत्क्रमज्यां चानीय तयोः क्रमज्यां पृथगिन्दोः नत्युत्क्रमज्यया पूर्वानीतया निहत्य त्रिज्यया विभजेत् । तत्र लब्धं **नतीषुफलं** नाम । तत् पृथक्स्थितायाः क्रमज्याया विशोधयेत् । तत्र [2]लब्धश्चन्द्रार्कयोर्विवरोत्पन्नो गुणः । अथ नत्युत्क्रमस्य **नतीषुफलस्य** च वर्गान्तरतो यन्मूलं तच्चन्द्रार्कान्तरोत्क्रमज्यायां प्रक्षिपेत् । स तयोर्विवरोत्पन्न उत्क्रमगुणः । अथ तस्माद् **विवरोत्क्रमगुणाद्** अर्कस्य नत्युत्क्रमगुणः सर्वदैव विशोध्यः । तत्र शिष्ट एको राशिः । नतीषुफलसंस्कृता चन्द्रार्कान्तरालज्या द्वितीयो राशिः । चन्द्रार्कयोर्नतिज्ययोर्भिन्नतुल्यदिशोर्योगोऽन्तरं[3] वा तृतीयो राशिः । तेषां **त्रयाणां** राशीनां **वर्गयोगमूलकृतलम्बनयोश्चन्द्रार्कयोरन्तरे** [4]प्रथमपदगते स्फुटं **बिम्बान्तर**मिति ॥ ९-१२ ॥

अथ द्वितीयपदगते बिम्बान्तरानयनायाह— [**कृतलम्बनेति** ।]

कृतलम्बनयोश्चन्द्रार्कयोर्विवरचापे राशित्रयादधिके सति तदर्धस्य क्रमज्यैव **ग्राह्या**, **न** पुनरुत्क्रमज्यापि । ततः तथा गृहीतां क्रमज्यामुभयत्र कृत्वा ते उभे अपि पूर्ववद् **रवीन्द्वोः** [5]उत्क्रमज्याभ्यां निहत्य **त्रिज्यया** विभजेत् ।

मूलम्— 1. C. उच्यते 2. B. Hapl. om. of **विवरोद्भवौ**
3. B. om. स्फुटम् 4. $C._{1-5\cdot 10}$ तत्तल्लम्बन

व्याख्या—1. A. उत्क्रमज्यां ; B. Hapl. om. of the word.
2. शिष्ट for लब्ध
3. C. योगमन्तरं 4. B. प्रथमस्फुटगते बिम्बा
5. C. नत्युक्रमज्याभ्यां

रवीन्दुनतिबाणघ्ना द्विष्ठा त्रिज्याहृता पृथक् ।
योज्ये स्वस्वफलोने ते जीवा सैवान्तरोद्भवा ॥ १४ ॥

नतीषुफलकृत्योर्ये भेदमूले तदन्तरम् ।
द्वितीयं चरमा प्राग्वन्नतियोगो भिदापि वा ॥ १५ ॥

त्रयाणामपि वर्गैक्यान्मूलं बिम्बान्तरं तदा ।
सदा[1] बिम्बान्तरार्धस्य चापं द्विगुणमन्तरम् ॥ १६ ॥

तत्र लब्धं फलद्वयं तयोरुभयोर्नतीषुफलं नाम[1] । तद्द्वयं पृथक्कृताभ्यां स्वस्वक्रमज्याभ्यां विशोध्य शिष्टे द्वे मिथो योजयेत् । सैवेहान्तरोद्भवा स्फुटा जीवा स्यात् । सा तावदिहैको राशिः । अथ रवीन्द्वोर्ये नत्युत्क्रमज्ये ये च तयोर्नतीषुफले तत्र तत्र रवेर्नत्युत्क्रमस्य [2]नतीषुफलस्य च यद्वर्गान्तरं यच्च चन्द्रस्यापि नत्युत्क्रमं तन्नतीषुफलयोर्वर्गान्तरम् । तयोरुभयोर्मूलयोरन्तरं द्वितीयो राशिः । तयोरेव नत्योर्दिग्भेदैक्यवशात् पूर्ववद्योगोऽन्तरं[3] वा तृतीयो राशिः[4] । तेषां त्रयाणां वर्गयोगमूलं द्वितीये पदे[5] स्फुटं बिम्बान्तराल-मिति ॥ १३-१६a ॥

एवमानीतमेव बिम्बान्तरालं दृग्विषये[6] स्फुटं भवतीत्याह—[सदेति ।]

भूपृष्ठावस्थितद्रष्टृमध्यं[7] चन्द्रार्कयोर्बिम्बघनमध्यद्वयावभेदि यद् दृङ्-मण्डलं परिकल्प्यते, यत्रार्कभासा तदभिमुखं चन्द्रबिम्बं दीप्यते[8] । यदुक्तं सिद्धान्तदर्पणे—

द्विस्पृग्वृत्तेऽर्कभासेन्दोरर्धं भात्यतिरोहितम् ॥

इति । (सिद्धान्तदर्पणम् , ३०)

मूलम्— 1. B. तदा

व्याख्या—1. C. Hapl. om. of तयोरुभयोर्नतीषुफलं नाम

2. C. तन्नतीषु 3. C. योगमन्तरं

4. B. om. वा तृतीयो राशिः 5. A. पादे

6. C_{1-8} दिग्विषये (wr.) 7. B. मर्कं (wr.)

8. A. भासते

रवीन्द्वोर्वलये तत्र द्रष्टृमध्योभयस्पृशि ॥ १७a ॥

[सितमानार्थं बिम्बान्तरम्]

तद्बाहुज्या च कोटिज्या चन्द्रदृक्कर्णताडिते ॥ १७b ॥

भुजाकोटिफले भक्ते [1]रविदृक्कर्णयोजनैः ।

ताभ्यां त्रिभज्यया[2] कर्णाच्छीघ्रन्यायेन दोःफलम् ॥ १८ ॥

चापितं धनमेवात्र बिम्बान्तरधनुष्यदः ।

कर्क्येणादौ त्रिभज्यायां स्वर्णं कोटिफलं त्विह ॥ १९ ॥

सितमानार्थमेवैवं रवीन्द्वन्तरमिष्यते ॥ २०a ॥

तत्रैवमानीतस्य बिम्बान्तरसमस्तज्यारूपस्य यदर्धं तस्यैव यच्चापं द्विगुणितं तदेव तयोर्बिम्बान्तरालमित्येतन्न क्वचिद् व्यभिचरति ॥१६b-१७a॥

[सितमानार्थं बिम्बान्तरम्]

अथैवमानीतस्य बिम्बान्तरालस्य चन्द्रबिम्बे सम्पादनायाह— [**तद्बाहुज्येति** ।]

उक्तवदानीते बिम्बान्तरे चापे राशित्रयादूने सति ततो गृहीता ज्या **बाहुज्या**। तच्चापं राशित्रयाद्विशोध्य शिष्टस्य[1] ज्या तत्**कोटिज्या** चेति। राशित्रयादधिके पुनः तस्मिन् ततो राशित्रयं विशोध्य शिष्टस्य ज्या कोटिज्या। तच्चापं राशित्रयाद्विशोध्य ज्या तद्बाहुज्येति। तां बाहुज्यां कोटिज्यां च **चन्द्रस्य दृक्कर्ण**योजनैः निहृत्य **रवेर्दृक्कर्णयोजनै**र्विभजेत् । तत्र लब्धे क्रमेण भुजाकोटिफले स्याताम् । तयोः कोटिफलं त्रिज्यायाम् अन्तरालचापस्य मृगकर्क्यादिगतत्ववशादृणं धनं च[2] कृत्वा तस्याः [3]तद्भुजाफलस्य च वर्गयोगाद्यन्मूलं तत्कर्णः स्यात्। ततः **शीघ्रस्फुटन्यायेन** तद्बाहुफलं त्रिज्यया निहृत्य तेन कर्णेन विभजेत् । तत्र लब्धफलस्य **यच्चापं** तत् बिम्बान्तरालधनुषि सर्वदा **धनमेव** कर्तव्यम्। न पुनः कदाचिदृणमिति । उक्तरूपमिदं रवीन्द्वोः **बिम्बान्तरानयनं सितमानार्थमेव** कर्तव्यम्, न पुनरन्यत्र ।

मूलम्— 1. A. विदृक्कर्ण (wr.) 2. A. त्रिभज्ये यत् (wr.)

व्याख्या—1. B. Hapl. om. after शिष्टस्य to शिष्टस्य, next line.

2. B. गते त्वधनं ऋणं च

3. B. तद्भुजास्य च ; C. तद्बाहु

उत्क्रमज्या ततो ग्राह्या क्रमज्या च समे पदे ॥ २०b ॥
बिम्बमानाहताद् बाणात् त्रिज्याढ्या च पदाधिके ।
तद्गुणात् कृत्स्नविष्कम्भभक्तमेव सितं सदा ॥ २१ ॥

[सितमानस्य वलनम्]

प्राग्वच्छायाभुजा भानोः स्वाग्राभ्यां[1] च विधोर्नयेत् ।
शङ्क्वग्रं सौम्यदिक्कं स्याद्दृश्यार्धगते ग्रहे ॥ २२ ॥
दृक्कर्णानयने शङ्कोः फलमप्यत्र योजयेत् ।
व्यासार्धात् [2]तद्धृताच्छायाभक्ते क्षितिजगे उभे ॥ २३ ॥

अथवा बिम्बान्तरमिदं सितमानार्थमेवमेव कर्तव्यम् । न पुनः प्रकारान्तरेण इति ॥ १७b-२०a ॥

अथ सितमानानयनार्थमाह— [उत्क्रमज्येति ।]

उक्तवदानीतादर्केन्द्वोः स्फुटान्तरालचापादोजपदे तस्मिन्नुत्क्रमज्यां, [1]युग्मपदे तु राशित्रयादधिकस्य क्रमज्यां त्रिज्यया सहितामानीय चन्द्रबिम्बमानकलाभिर्निहत्य कृत्स्नविष्कम्भेण द्विगुणितत्रिज्यातुल्येन विभजेत् । तत्र लब्धं सितमानं भवति । सदेत्यनेन प्रकारान्तरं पराकरोति[2] ॥ २०b-२१ ॥

[सितमानस्य वलनम्]

अथास्य सितमानस्य वलनानयनायाह— [प्राग्वच्छायेति ।]

तत्र भानोश्चन्द्रस्य च छायाभुजां शङ्क्वग्रार्काग्राभ्यां प्राग्वदेवानयेत् । यथोक्तं प्राक्—

> अक्षज्याघ्नान्महाशङ्कोः शङ्क्वग्रं लम्बकाहृतम् ।
> सर्वदा दक्षिणं तद्धि योज्यमर्काग्रयापि तत् ॥
> याम्ये गोले महाबाहुः सौम्ये चाग्रद्वयान्तरम् ।
> अधिकेऽग्रापि शङ्क्वग्रे याम्यः स्यादन्यथोत्तरः ॥

इति । (तन्त्रसंग्रहः, ३.४७-४८)

मूलम्— 1. A. स्वग्राभ्यां 2. C. तद्धृतात् (wr.)

व्याख्या—1. B. Duplicates युग्मपदे to क्रमज्यां

2. C. परं करोति (wr.)

योगस्तद्धनुषोः कार्यो यथा युक्त्यन्तरं तथा।
छायाबाह्वोर्दिशोर्भेदे योगः साम्येऽन्तरं तथा ॥ २४ ॥
विश्लेषचन्द्रबाहुश्चेत्[1] शिष्टः स्याद् व्यत्ययेन दिक्।
सूर्यस्यैव ततोऽन्यत्र ग्राह्या दिग् योगभेदयोः ॥ २५ ॥

इन्द्वग्रस्यापि तस्य परमापक्रमस्य सिद्धत्वात्—

साघनेन्द्वोर्भुजाज्यां[1] स्वपरमक्रान्तिताडिताम् ॥
लम्बकेन विभज्येन्द्वोरग्रज्या साध्यतेऽर्कवत् ॥

इति सुकरैवम्। शङ्क्वग्रानयनमप्युभयोः समानमेव। किन्तु अदृश्यार्धगते ग्रहे शङ्क्वग्रं सौम्यदिग्गतमेव भवतीति। तत्र—

छायाशङ्कू रवेस्ताभ्यां भूव्यासार्धस्य योजनैः।
हताभ्यां त्रिज्यया लब्धे बोःकोटी योजनात्मिके ॥
रविभूम्यन्तरात् कोटिं त्यक्त्वा तद्बाहुवर्गयोः।
योगात् पदं भवेद् भानोः दृक्कर्णो योजनात्मकः ॥
(तन्त्रसंग्रहः, ५.३७-३८)

इत्यत्र दृक्कर्णानयने द्वितीयस्फुटकर्णतः शङ्कुफलस्य शोधनीयत्वं यदुक्तं तदिह अदृश्यार्धगते ग्रहे[2] योज्यमेव। एवंकृतस्य द्वितीयस्फुटकर्णस्य छायाफलस्य च वर्गयोगमूलं दृक्कर्ण इति। अथोक्तवदानीते अर्केन्द्वोः छायाभुजे द्वे अपि त्रिज्यया निहत्य छायया विभजेत्। तत्र लब्धे द्वे अपि क्षितिजगते स्याताम्। येन तयोः त्रिज्यावृत्तगतत्वात् चापीकरणं सुकरं स्यात्। ततस्तयोः चापयोर्दिशोर्भेदे मिथो युञ्ज्यात्। दिक्साम्ये च विश्लेषं कुर्यात्। तत्र विश्लेषे चन्द्रबाह्वोः शिष्टत्वे व्यत्ययेन दिग् ग्राह्या। अन्यत्र [3]सूर्यबाह्वोः शिष्टत्वे छायाभुजाचापयोर्योगे च सूर्यस्यैव छायाभुजाया दिग् ग्राह्या।

मूलम्— 1. A. om. चेत्
व्याख्या—1. C. भुजाभ्यां (wr.) 2. A. B. अदृश्यार्धग्रहे
3. C. om. सूर्य

स्वभूम्यन्तरनिघ्नस्वदृग्ज्या दृक्कर्णभाजिता ।
अर्केन्द्वोः सुस्फुटा दृग्ज्या द्रष्टृभूपृष्ठगस्य हि ॥ २६ ॥

बाहुचापान्तरज्याघ्ना दृग्ज्या त्रिज्याहृता रवेः ।
चन्द्रबिम्बार्धनिघ्नाथ बिम्बान्तरभुजाहृता ॥ २७ ॥

उन्नतिश्चन्द्रशृङ्गस्य नतिर्वार्धगुणात्मिका ।
वर्गत्रयैक्यमूलस्य दलस्य द्विगुणं धनुः ॥ २८ ॥

यत्तस्य बाहुजीवात्र बिम्बान्तरभुजोदिता[1] ॥ २९a ॥

[शृङ्गोन्नतेः परिलेखनम्]

चन्द्रबिम्बार्धमानेन लिखेद् वृत्तं तु, तद्गते ॥ २९b ॥

रेखे द्वे दिग्विभागार्थं, प्रत्यग्रेखाग्रतः[2] पुनः ।
नीत्वा शृङ्गोन्नतेर्मानं प्राग्वदर्धगुणात्मकम् ॥ ३० ॥

अथ **अर्केन्द्वोः दृग्ज्याद्वयं** स्वेन द्वितीयस्फुटयोजनकर्णेन निहत्य **दृक्कर्ण**-योजनैर्विभजेत् । तत्र लब्धे **भूपृष्ठगतस्य द्रष्टुः** सम्बन्धिन्यौ **स्फुटे**[1] **दृग्ज्ये** स्याताम् । अथ छायाभुजाचापयोगान्तरतो वा ज्यामानीय स्फुटया स्वस्वदृग्ज्यया निहत्य **त्रिज्यया** विभजेत् । तत्र लब्धं फलं पुनरपि **चन्द्र-बिम्बव्यासार्धेन** निहत्य **बिम्बान्तरभुजया** विभजेत् । तत्र लब्धा **चन्द्र-शृङ्गस्योन्नतिरवनतिर्वा अर्धज्यात्मिका** स्यादिति । **बिम्बान्तरभुजा** च त्रयाणां राशीनां वर्गयोगमूलस्यार्धीकृतस्य यच्चापं द्विगुणितं प्रागेव प्रदर्शितं तद् भुजाया अर्धज्येति ॥ २२-२९a ॥

[शृङ्गोन्नतेः परिलेखनम्]

अथैवामानीतां शृङ्गोन्नतिं परिलेखनेन स्पष्टीकर्तुमाह— [**चन्द्र-बिम्बार्धेति** ।]

तत्र **चन्द्रबिम्बस्य** व्यासार्धमानेन कर्कटेन **वृत्तमालिख्य** तन्मध्ये बिम्बकेन्द्रावभेदिनीं समपूर्वापरां समदक्षिणोत्तरां च **रेखां** कुर्यात् । येनात्र

मूलम्—1. A. भुजोदितम्　　2. C. रेखाग्रता (wr.)

व्याख्या—1. C. स्फुटौ (wr.)

चन्द्रादर्कदिशीन्दोस्तु परिधौ प्राग्विपर्ययात् ।
बिन्दुं कृत्वा लिखेद् रेखां तन्मार्गेण सितं नयेत् ॥ ३१ ॥

प्रत्यगग्रात् सिते पक्षे प्रागग्रादसितेऽपि च ।
सितान्ते बिन्दुमाधाय तिर्यग्रेखाग्रयोस्ततः ॥ ३२ ॥

बिन्दुं कृत्वा लिखेद् वृत्तं बिन्दवो नेमिगा यथा ।
वृत्तान्तराकृतिश्चन्द्रः शृङ्गोन्नत्या प्रदर्श्यताम् ॥ ३३ ॥

व्यस्तदिक्कोऽर्कबाहुः स्यात् तयोर्नानाकपालयोः ।
प्रत्यासन्नरवेर्भागादिहाप्यन्तर्नयेत् सितम् ॥ ३४ ॥

विग्विभागः स्यादिति । ततः पूर्वापररेखायाः प्रत्यगग्राच्चन्द्रतोऽर्कविस्थितदिशि, प्रागग्रात् तद्विपरीतदिशि च तत्परिधावर्धगुणात्मकं शृङ्गोन्नतेः मानं उक्तवदानीतं नीत्वा बिन्दुद्वयमपि[1] विरचय्य तद्द्वयस्पृष्टां बिम्बकेन्द्रावभेदिनीं अपरामपि रेखां कुर्यात्[2] । ततस्तद्द्वितयावष्टब्धकेन्द्रयोरुभयोर्वृत्तयोः परिधिभेदोत्पन्नमत्स्यानुसारेण तत्समतिर्यग्गतामपरामपि रेखां कुर्यात् । सा तिर्यग्रेखा नाम ।

तयोराद्यरेखायाः प्रत्यगग्रात् सिते पक्षे तन्मार्गेण सितमानं [3]बिम्बान्तर्नयेत् । ततः सितान्ते तस्यामेव रेखायां बिन्दुमाधाय तत्तिर्यग्रेखाग्रयोरप्युभौ बिन्दू कुर्यात् । एवंकृतेषु त्रिषु बिन्दुषु तत्त्रितयावगाढनेमिकमपरमपि[4] वृत्तं[5] विरचयेत् । तत एवंकृतस्यास्य त्रिस्पृग्वृत्तस्य [6]चन्द्रबिम्बार्धवृत्तस्य च यद् बिम्बनेम्योरन्तरालं तस्य [7]सुधादिना धवलीक्रियमाणस्येवाकृतिर्यस्य तादृशश्चन्द्रः तदानीं शृङ्गोन्नत्या समुपरक्षितः सन् प्रदर्श्यताम् ।

व्याख्या—1. A. om. अपि

2. B. Hapl. om. after कुर्यात् to कुर्यात्, next line.

3. C. बिम्बान्तं 4. A. नेमितोपरमपि; C. नेमितमपरमपि

5. A. बिन्दं (wr.) 6. C. om. चन्द्रबिम्बार्धवृत्तस्य

7. C. om. सु

अन्यस्मादसितं वापि सर्वमन्यद् यथोदितम् ॥ ३५a ॥

[अर्कास्तमयात्परं चन्द्रस्योदयादिगणना]

उदयास्तमयाविन्दोरविशेषेण सिद्ध्यतः ॥ ३५b ॥

यदा पुनरर्केन्दू भिन्नकपालौ[1] स्यातां तदार्कस्य छायाबाहुर्व्यस्तदिक्कोऽवगन्तव्यः । तत्र चक्रार्धान्तरितादेवार्कतस्तद्बाहोरिष्यमाणत्वात् तस्य च प्रागुक्तवैपरीत्यादिति । तत्रापि सितमानानयनं **प्रत्यासन्नरवेर्भागादेव** ।

एतदुक्तं भवति— यद्यप्यर्केन्द्वोर्भिन्नकपालावस्थितयोः सतोरर्कबाहुः चक्रार्धान्तरितादेवार्कतो ग्राह्यः, तथापि सितमानं चन्द्रबिम्बे सूर्याभिमुखस्यैवार्धस्य वेदितव्यम् । तत्करस्पर्शादेव तदानीं तस्य शौक्ल्योपलम्भाद् असितमानं पुनस्ततो व्यस्तदिग्गतमेव, तत्रैव [2]तत्करस्पर्शप्रतिबन्धान्मालिन्योपलम्भात् तत्रापि चन्द्रबिम्बगतया अर्धगुणात्मिकया शृङ्गोन्नत्या तन्मध्यगतप्रागपरसूत्रस्य प्राक्प्रत्यग्ग्राभ्यां बिन्दोः सञ्चालनं, तदुभयस्पृष्टरेखान्तरविरचनं, तत्तिर्यग्रेखापरिकल्पनम्, तद्रेखानुसारेण[3] तदग्रतो बिम्बान्तरसितमानप्रवेशनं, तदग्रे तिर्यग्रेखाग्रयोश्च बिन्दुत्रयविरचनं, त्रिस्पृग्वृत्तपरिलेखनं,[4] बिम्बपरिध्यन्तरालेनासितमानप्रदर्शनं च पूर्ववदेव । किन्तु तत्र बिम्बपरिध्यन्तरालस्य मष्यादिविलेपनतो[5] मालिन्योत्पादनेनासितमानं प्रदर्शयितव्यमिति ॥ २९b-३५a ॥

[अर्कास्तमयात्परं चन्द्रस्योदयादिगणना]

एवं चन्द्रबिम्बसितमानशृङ्गोन्नत्यादिकं सप्रपञ्चं प्रदर्शितम् । इदानीं तस्यैव अर्कास्तमयात्परं उदयादिकालपरिज्ञानम् उक्तमार्गेणैव सेत्स्यतीत्याह— **[उदयास्तमयेति ।]**

इन्दोरुदयादिकालावगत्यर्थम**विशेषं** कर्मैव अभिधातव्यं, दृक्कर्मादीनां प्रागेव प्रदर्शितत्वादिति । तत्र तावत् कृष्णपक्षे सूर्यास्तमयकालोत्थौ स्फुटावर्केन्दू समानीयार्के राशिषट्कं च क्षिप्त्वा स्फुटादावुदयोक्तं[6] दृक्कर्म-

व्याख्या—1. B. कपाले

2. A. तत्करस्पर्शोपलम्भात्; C. तत्करस्पर्शगतिलम्भात्

3. C. तत्तिर्यग्रेखानुसारेण　　4. A. om. त्रिस्पृग्वृत्तपरिलेखनं

5. C. विलेखनतो　　6. C. स्फुटोभावुदयोक्तं

मध्यप्राप्तिश्च कालश्च छाययैष्यो गतोऽपि वा ॥ ३६[a] ॥

युगलं च तयोः कृतप्राणकलान्तरयोः विवरकलाभिः प्राणतुल्याभिः त्रैराशिकेन स्फुटगतिद्वयमानीय तयोः[1] प्रक्षिपेत् । पुनरप्येवंकृतस्य चन्द्रस्य कृतदृक्कर्मयुगलस्यार्कस्य च केवलस्य कृतप्राणकलान्तरचरयो[2]र्विवरप्राणैः स्फुटगतिमानीय प्राच्ययोरेव[3] चन्द्रार्कस्फुटयोः प्रक्षिप्य उक्तवदेव [4]तद्विवरप्राणान् मुहुरानयेत्, यावदविशेषः। अविशिष्टः सोऽर्कास्तमयाच्च[5] चन्द्रोदयावधिकः कालो भवति। एवं शुक्लपक्षे तदस्तमयकालोऽपि वेदितव्यः। किन्तु, तत्र चन्द्रे अस्तमयोक्तं दृक्कर्मयुगलं कार्यम् । **मध्यप्राप्तिकालानयनमप्येवमेव कार्यम्** । किन्तु तत्रायनमेव दृक्कर्म कार्यम् । तदप्युक्तम् **अमुनैव**—

> **दृक्क्षेपः काललग्नस्य क्रान्तिरेव खमध्यगे ।**
> **क्रान्तिक्षेपविशोर्भेदे धनं साम्ये त्वृणं तदा ॥**
>
> (चन्द्रच्छायागणितम्, २३)

इति ।

सर्वत्रापि तत्तद्दृक्कर्मसंस्कृतो ग्रह एव लग्नम्[6]। यदुक्तम्—

> **उदयास्तखमध्येषु लग्नमेवंकृतो ग्रहः ॥**
>
> (चन्द्रच्छायागणितम्, २४)

इति । तत्र कृतप्राणकलान्तरमेव[7] मध्यलग्नं मध्यकालः, कृतप्राणकलान्तरचरमुदयलग्नमुदयकालः । तदुक्तम्—

> **मध्यलग्नं स्वकालः स्यात् कृते प्राणकलान्तरे ।**
> **चरं चोदयलग्नस्य कुर्यात् कालप्रसिद्धये ॥**

इति ।

मध्यलग्नस्याविशेषणमप्युक्तम्—

> **सन्निभो लग्नकालः स्यात् तत्क्रान्तीन्द्वादिभिर्मुहुः ।**
> **मध्यलग्नं तथा कार्यं यावन्निश्चलतामियात् ॥**
>
> (चन्द्रच्छायागणितम्, २५)

इति ।

व्याख्या—1. B. आनीतयोः (wr.)
2. C. कलान्तरस्य चरयोः 3. C. प्राचीनयोरेव
4. A. पदात् for तत् 5. C. अस्तमयः for अस्तमयाच्च
6. B. बलनम् for लग्नम् 7. B. कलान्तरमध्यमेव

अस्तलग्नं तस्याविशेषणमपि[1]—

अस्तलग्नं सचक्रार्धं प्राग्लग्नं, तस्य कालतः ।

चन्द्रदृक्क्षेपकालादि नीत्वा तमविशेषयेत् ।।

(चन्द्रच्छायागणितम्, २६a-२७b)

इति । एवंकृतस्य लग्नकालस्य रविकालस्य च यो भेदः स दिवानिशोः काल इति । तदुक्तम्—

रविकालस्य तस्यापि भेदः कालो दिवानिशोः ।।

(चन्द्रच्छायागणितम्, २७b)

इति ।

तत्र खमध्ये रविकालो राशित्रयविरहितः कृतप्राणकलान्तरो रविरेव । ततस्तस्य मध्यकालस्यापि[2] विवरप्राणान् प्राग्वदविशेष्य तन्मध्यप्राप्तिकालोऽपि साधयितव्य एव । तथा चन्द्रस्य छायया गतैष्यकालानयनं सिध्यत्येव । तद्यथा—प्रथमं छायावाक्यैः स्वदेशपठितैः चन्द्रस्य गतगन्तव्यनाडीरवगम्य ऊहसिद्धं[3] तत्कालचन्द्रं लग्नं च अवगम्य लग्नार्कान्तिरनाडिकाश्चानयेत् ।[4] ऊहसिद्ध[5]नाडिकादिगतिसंस्कृतस्य चन्द्रस्य लग्नत्वात्[6] ततो लग्नेऽर्के च प्राणकलान्तरं चरं च विधिवत् कृत्वा लग्नकालात् सूर्यकालं विशोध्य शिष्टा गन्तव्यासवः, अन्यथा गतासवः । दिनमानादधिकाश्चेद् राशिगत[7]नाड्यादिकमिति ज्ञेयम् । एवंसिद्धाभिर्गतगन्तव्यनाडीभिस्तत्कालेन्दुमवगम्य दृक्कर्म विधिवत् कृत्वा लग्नं लग्नकालं च आनीय तस्य रविकालस्यापि भेदतो गतगन्तव्यप्राणानानीय कुत्रचिद् रक्षेत् । अथ प्रकारान्तरेणापि गतगन्तव्यप्राणानानीय तान् पूर्वानीतैः[8] सह विश्लेष्य शिष्टस्फुटगतिमानीय तत्कालचन्द्रार्कयोर्धनमृणं च कुर्यात्, यदि प्रकारान्तरसमानीता अधिकाः स्युः । अन्यथा पुनर्ऋणधने व्यत्ययतः कार्ये[9] । एवं गन्तव्यकालविषये ज्ञेयम् । गतकालविषये पुनर्व्यत्ययेनेदं कर्म असकृत् कुर्यात्, यावदुभयथा समानीतयोः कालयोः साम्यं स्तात् । एतत्सर्वममुनैवान्यत्र प्रदर्शितम्—

व्याख्या—1. A. अस्तलग्नस्याविशेषणमपि

2. C. Hapl. om. after पि to कालोऽपि, following.

3. A om. गम्य ऊहसिद्धं 4. C. adds साधयेत्

5. A. ऊहसिद्धगम्य ऊहसिद्धं (wr.)

6. B. चन्द्रलग्नत्वात् 7. A. रात्रिगत (wr.)

8. A. पूर्वमानीतैः 9. C. om. कार्ये

[कुजादीनां कक्ष्याद्यानयनम्]

रविवच्चन्द्रकक्ष्याया नेयाऽन्येषां हि सा[1] ततः ॥ ३६b ॥

शङ्कुच्छायाकृती युक्त्वा स्वकर्णार्थं पदं नयेत् ।
याम्योदग्भूगुणो[1]नाढ्या द्युज्यान्त्या, विषुवच्छ्रुतेः[2] ॥

त्रिज्याघ्नायाः स्वकर्णाप्ता हीनान्त्या त्रिज्यया हृता ।
द्युज्याप्ता चापिता बाणैर्नतप्राणविधोरमी ॥
त्याज्या मध्याह्नकालात् प्राक्, क्षेप्याः प्रत्यग्गतासुभिः[3] ।
एभिर्विश्लिष्यपूर्वोक्तानन्तरप्राणभोगतः ॥
नीत्वार्केन्द्वाधिकं भूयः कुर्यात् कर्मासकृत् तथा ।
साम्यसिद्ध्यै रवीन्दुभ्यां सिद्धयोः कालयोर्द्वयोः ॥

(चन्द्रच्छायागणितम्, २८-३१)

इति ।

इदमेव हि प्रकारान्तरेण गतगन्तव्यप्राणानयनम् । तद्यथा—अङ्गुलात्मिकयोः छायाशङ्क्वोर्वर्गयोगमूलेन तत्कर्णमानयेत् । अथ याम्योदक् स्वक्षितिज्यया ऊना सहिता च स्वद्युज्यान्त्या नाम । अथ त्रिज्यागुणितां विषुवच्छ्रुतिं छायाकर्णेन विभज्य लब्धमन्त्यतो विशोध्य शिष्टं त्रिज्यया हृत्वा स्वद्युज्यया विभज्य लब्धमुत्क्रमज्याभिश्चापीकुर्यात् । तच्चापकला विधोर्नतप्राणाः स्युः । तान् नतप्राणान् दिनार्धप्राणतो विशोध्य उन्नतप्राणानानीय पूर्वानीतैः सह विश्लेषयेत् । तत्र शिष्टस्य स्फुटगतिमानीय चन्द्रार्कयोः कुर्यात् । तत्प्रकारस्तु प्रागेव दर्शितः । एवंकृताभ्यां रवीन्दुभ्यां भूयोऽप्येतत्कर्म कुर्यात्, यावद् द्वयोः[4] कालयोः साम्यमिति । अविशिष्टश्च गतैष्यकालः समीचीनः स्यादिति ॥ ३५b-३६a ॥

[कुजादीनां कक्ष्याद्यानयनम्]

अथ कुजादीनां कक्ष्याद्यानयनं दर्शयति—[रविवच्चन्द्रेति ।]

मूलम्—1. B. ता for सा

व्याख्या—1. C. भूगणो (wr.) 2. B. श्रुतौ

3. A. B. C. प्रत्यगथासुभिः । But the original text of *Candracchāyāgaṇita* reads प्रत्यग्गतासुभिः

4. C. यावद्द्वयोः (wr.)

भेदे समागमादौ च लम्बनाद्येवमेव हि ॥ ३७a ॥

[बुधशुक्रयोः कक्ष्याद्यानयनम्]

शीघ्रकर्णघ्नकक्ष्यायास्तद्वृत्तेन सितज्ञयोः ॥ ३७b ॥
आप्ता हि स्फुटकक्ष्या स्यात्, तद्वशाल्लम्बनादि च ॥ ३८a ॥

[बिम्बमानादीनां दृक्साम्यपरीक्षणम्]

चक्रांशाद्यङ्किते[1] वृत्ते तन्मध्यासक्तचक्षुषा ॥ ३८b ॥

अन्येषां कुजादीनां सा कक्ष्या चन्द्रकक्ष्यातो रविवन्नेया । यथा[1]—

वशाभ्यस्ता त्रिजीवेन्दोः कक्ष्याव्यासार्धयोजनम् ।
तच्चन्द्रभगणाभ्यस्तं कुजादेर्भगणोद्धृतम्[2] ।

(तन्त्रसंग्रहः, ४. ८b-९a)

इति । ततस्तस्या एव कक्ष्याया भेदे समागमे युद्धादौ च तस्य तस्य लम्बनमपि ग्रहणोक्तन्यायेनैवावगन्तव्यमिति ॥ ३६b-३७a ॥

[बुधशुक्रयोः कक्ष्याद्यानयनम्]

अथ बुधशुक्रयोरपि [3]तदानयनायाह—[शीघ्रकर्णघ्नेति ।]

[4]सितज्ञयोरुक्तवदानीतं कक्ष्याव्यासार्धयोजनं स्वशीघ्रकर्णेन निहत्य शीघ्रवृत्तप्रमितस्ववृत्तव्यासार्धेन विभजेत् । तत्र लब्धा स्फुटकक्ष्या भवति । अन्येषां तु प्राग्वल्लब्धं[5] कक्ष्याव्यासार्धं स्वशीघ्रकर्णगुणितं त्रिज्यया[6] विभक्तमिति विशेषः । एवमानीतेन स्फुटकक्ष्याव्यासार्धेन स्वस्वविक्षेपदृक्क्षेपादिना[7] च विधिवत् समानीतेन लम्बनावनत्यादिकं सर्वं कर्तव्यमिति । तद्विषयं यद्वक्तव्यं तत्सर्वमुक्तमेवेति ॥ ३७b-३८a ॥

[बिम्बमानादीनां दृक्साम्यपरीक्षणम्]

उक्तरूपस्यास्य दृक्साम्यपरीक्षार्थमाह—[चक्रांशाद्येति ।]

मूलम्—1. B. चक्रांशाद्यंकिते

व्याख्या—1. C. om. यथा

2. For कुजादेः etc. *Tantrasaṅgraha*, 4.9a, reads : भानोः स्वभगणोद्धृतम् ।

3. C. कक्ष्या for तत्

4. A. सितज्ञयोरपि उक्त

5. A. लम्ब for लब्धं (wr.)

6. C. त्रिज्याया (wr.)

7. B. दृक्क्षेपविक्षेपादिना, C. दृक्क्षेपादिना

ज्ञेयं ग्रहान्तरं बिम्बदृग्ज्याचापादिकं स्फुटम् ॥ ३९a ॥

[ग्रन्थोपसंहारः]

गोलः कालः क्रिया चापि द्योत्यतेऽत्र मया स्फुटम् ॥ ३९b ॥

चक्रांशैः[1] षष्ट्युत्तरशतत्रयपरिमितैरङ्कितं यद् वृत्तम् । आदिशब्देन तत्कलाभिर्वा खखषड्घनपरिमिताभिः । तन्मध्ये समासक्तचक्षुषा गोलविदा ग्रहान्तरं बिम्बदृग्ज्याचापादिकं च स्फुटं ज्ञेयम् । कथमिति चेत्—तद् वृत्तमध्यं चक्षुर्गोलसन्निहितं कृत्वा अभीष्टग्रहद्वयस्फुटपरिधिकं यथा भवति तथा कृते तस्मिन्नभीष्टग्रहान्तरालपरिधिभागे यावन्तोंऽशाः कला वा सम्भवन्ति[2] तावदेव तयोर्बिम्बान्तरम् । एवं तत्तद्बिम्बमानं दृग्ज्याचापादिकमपि स्फुटमेव विज्ञातुं शक्यमिति ॥ ३८b-३९a ॥

[ग्रन्थोपसंहारः]

इदानीमुक्तरूपं प्रकरणविशेषमुपसंहरन् अस्य सर्वव्यापितां दर्शयति—[गोलः काल इति ।]

[3]यद्यप्यस्मिन्[4] गणितविशेष एव सम्यक् प्रदर्शितः, तथाप्यस्य समीचीनां युक्तिपदवी[5]मपह्नुवानेन मया गोलो गणितगम्यक्षेत्रविशेषः, कालक्रिया च तत्-परिच्छेदिका[6] स्पष्टतरमेव[7] प्रकाशिते[8] स्याताम् । नन्वन्यप्रदर्शनेन अन्यस्य[9] प्रकाशनं कथमित्यत आह- लक्ष्मीशनिहित[10]ध्यानैरिति । यतः परममङ्गलदेवता-लीलावलोकनवशंवदे भगवति भक्तानुग्रहपरे लक्ष्मीनारायणाख्ये[11] निहितं[12] ध्यानं

व्याख्या—1. B. शक्रांशैः (wr.) 2. A. वा भवन्ति
3. B. यद्यस्मिन् 4. C. adds. प्रबन्धे
5. B. सरणि for पदवी 6. C. adds. स्फुटं
7. C. adds. द्योत्यते 8. C. प्रकाश्यते
9. B. अन्यतः
10. B. Hapl om. after निहित to निहितं, next line.
11. C. adds निहितध्यानैः 12. C. adds आवेशितं

लक्ष्मीशनिहितध्यानैरिष्टं सर्वं हि लभ्यते ॥ ४० ॥

[इति तन्त्रसंग्रहे शृङ्गोन्नतिप्रकरणं नाम
अष्टमोऽध्याय: ॥]

प्रत्ययैकतानता येषां तैः । इष्टं सर्वं अविकलं लभ्यत एव[1] । हि इत्यनेन प्रकरण-[2] समाप्तिसमयाहर्गणश्च दर्शितो 'लक्ष्मीशनिहितध्यानैः' (16,80,553) इत्यक्षरसङ्ख्यया इति[3] ॥ ३९b-४० ॥

इति तन्त्रसंग्रहस्य क्रियाकलापं क्रमेण संगृह्य ।
रचिते तद्व्याख्याने पूर्णोऽभूद् अष्टमोऽध्याय: ॥

॥ इति तन्त्रसंग्रहे सव्याख्याने
अष्टमोऽध्याय:[4] ॥

व्याख्या—1. C. adds : अतएव तदावेशलब्धतादात्म्यैरभीष्टं सर्वमेव लभ्यत इत्यनेन आत्मना क्रियमाणस्य प्रबन्धस्य गौरवातिशयशालितां प्रदर्शयता परमात्मन्यौद्धत्यं च परिहरति ।

2. B. प्रकर्षण (wr.); C. प्रकारेण (wr.)

3. C. adds सर्वमवदातम्

4. A. adds : समाप्त: ग्रन्थश्चायम् । C. om. this colophon, but adds : समाप्तं चेदम् । One of the mss. of C has the scribal verse giving the date of its transcription as Kali 18,03,25 in A.D. 1836 :

'कामारिलीनहृत्के'न कलितेन गुरूम्मया ।
तन्त्रसंग्रहटीका तु लिखिता शोध्यतां बुधैः ॥

APPENDIX I

INDEX OF HALF-VERSES AND KEY PASSAGES IN THE TANTRASAṄGRAHA

[*Note.* The numbers following the *pratīkas* refer to the chapter and verse and those at the end of the lines, to the pages.]

APPENDIX II

INDEX OF AUTHORITIES CITED

IN THE TANTRASAṄGRAHA AND ITS COMMENTARIES

[*Note* : The numbers refer to pages.]

APPENDIX III

INDEX GLOSSARY OF TECHNICAL TERMS

[*Note* : The references are to pages and are only indicative and not exhaustive.]

चक्र (circle, cycle), 155

चक्रलिप्ता (mintutes contained in a circle, being 21600), 155

चतुरस्र (quadrilateral), 80, 81

चन्द्रग्रहण (lunar eclipse), 251ff.

चर (declinational ascensional difference), 153 ff.

चरज्या (Rsine *caradala*)

चरदल (= चरार्ध) (half ascensional difference), 153ff.

चरप्राण (=चरासु), (*prāṇas* or *asus* of ascensional difference), 153-56

चरार्ध (= चरदल) (half ascensional difference)

चान्द्र (lunar), 5, 6, 7

चान्द्रमास (lunar month ; period from one new moon to the next, equal to about 29·53 civil days)

चाप (arc), 80, 94ff.

चार (motion), 2

छादक (=ग्राहक), (eclipsing body)

छाद्य (=ग्राह्य), (eclipsed body)

छाया (1. shadow), 181ff.; (2. Rsine of zenith distance, *i. e.*, *mahācchāya*), 209ff.

छेद (denominator)

छेद्यक (figure, diagram)

जीवा (=ज्या) (Rsine)

जूक (sign *Tulā*, Libra), 314

ज्या (Rsine), 80, 94ff.

ज्याखण्ड (segment of arc ; sine segment, sine difference), 109ff.

ज्यार्ध (=ज्या) (Rsine)

ज्योतिश्चक्र (circle of asterisms), 2, 6, 247

झष (=मत्स्य) (figure of fish formed in geometrical diagrams), 189, 190, 212

तम (1. shadow cone of the earth at the Moon's distance) ; (2. Moon's ascending node)

ताराग्रह (star planets, *viz.*, Mars, Mercury, Jupiter, Venus and Saturn), 270

तिथि (lunar day, *i.e.*, thirtieth part of the lunar or synodic month), 10, 171, 327

तिथिक्षय (=अवमतिथि), (omitted lunar days), 10, 12

तिथ्यन्त (end of the new moon *tithi* or the full moon *tithi*)

त्रिज्या (1. Rsine 90°) ; (2. The radius of length 3438 units, with the length of a minute of arc taken as unit, and corresponding to unity in the tabular sines), 154, 257, 269

त्रिभज्या (=त्रिज्या), 332

त्रिभुज (triangle)

त्रैराशिक (rule of three), 48-54

त्र्यस्र (=त्रिभुज), (triangle)

दक्षिणोत्तरमण्डल (-वृत्त), (meridian circle), 156, 187

दक्षिणोत्तररेखा (1. north-south line; 2. meridian ; 3. solsticial colure), 188ff.

दल (half)

दिक् (direction), 333, 336

भुज (=भुजा) (1. lateral side of a rt. angled triangle ; 2. of the angle, the degrees gone in the odd quadrants and to go in the even quadrants)

भुजज्या (Rsine)

भुजान्तरफल (correction for the equation of time due to the eccentricity of the ecliptic)

भुजाफल (equation of the centre)

भू (=भूमि) (Earth), 186

भूगोल (earth-sphere), 68, 186-88, 255, 268ff.

भूच्छाया (earth's shadow), 251ff.

भूदिन (terrestrial day, civil day, sunsrise to sunrise), 10ff.

भूपरिधि (circumference of the Earth, 3350 *yojanas*), 70

भूभ्रमण (earth's rotation), 10

भोग (भुक्ति) (motion, daily motion)

मण्डल (1. circle ; 2. orb), 310

मति (optional number in pulveriser), 55

मत्स्य (=झष), (figure of fish formed in geometrical diagrams), 189, 190, 212

मध्यगति (mean motion)

मध्यग्रहण (= ग्रहणमध्य) (mid-eclipse), 296, 305ff.

मध्यगति (-भुक्ति) (mean daily motion)

मध्यग्रह (mean planet), 165-67

मध्यच्छाया (midday shadow)

मध्यज्या (meridian sine, *i.e.*, Rsine of the zenith distance of the meridian-ecliptic point), 292

मध्य (धन) (middle term in a series)

मध्यन्दिनच्छाया (midday shadow), 201ff.

मध्यभुक्ति, (-गति), (mean daily motion), 5

मध्यम (mean)

मध्यलग्न (meridian ecliptic point), 247-50, 291, 321, 338

मध्यस्फुट (Mean planet), 48ff.

मध्याह्नच्छाया (midday shadow), 190

मन्द (slow ; *mandocca*, apogee of slow motion ; see also *mandocca*)

मन्दकर्ण (hypotenuse associated with *mandocca* ; radius vector), 159ff.

मन्दकर्म (*manda* operation in planetary computation)

मन्दकेन्द्र (*manda* anomaly)

मन्द(केन्द्र)फल (*manda* correction, equation of the centre), 158

मन्द (नीचोच्च)वृत्त (*manda* epicycle; epicycle of the equation of the centre), 151-64

मन्दपरिधि (epicycle of the equation of the centre)

मन्दोच्च (=तुङ्ग) (apogee or aphelion; higher apsis re-

rt. ascensional difference), 194-97

लम्ब (1. altitude ; 2. co-latitude), 80, 81

लम्बक (plumb), 189, 190

लम्बज्या (Rsine co-latitude, *i.e.*, Rcos latitude), 192

लम्बन (1. =लम्ब, Rcos latitude), 191ff.; (2. parallax in longitude, or the difference between the parallaxes in longitude of the Sun and the Moon, in terms of time), 199ff., 289, 293, 294

लम्बननाडिका (parallax in longitude in terms of *nāḍīkās*), 293-94

लम्बनयोजन (parallax in terms of *yojanas*)

लाट (a type of *vyatīpāta*, which occurs when Sun *plus* Moon is equal to 180°), 311ff.

लिप्ता (=कला) (minute of arc)

लिप्ताव्यास (angular diameter in minutes)

वक्र (retrograde), 270

वक्रगति (-चार, विगति) (retrograde motion), 155, 270

वर्ग (square), 22, 30-36

वर्गमूल (square root), 22, 36-39

वर्गसङ्कलित (sum of a series of squares of natural numbers), 91-92

वलन (deflection due to *akṣa*, latitude, or due to *ayana*, declination), 275-77 ; 333-35

वल्ली (series of results in *Kuṭṭaka* *i.e.*, *Kuṭṭākāra* operation; *lit.* 'creeper'), 55

वायु — See प्रवहवायु

वायुगोल ('Atmospheric sphere'), 186-88, 210, 247ff, 268ff.

विकला (=विलिप्ता) (second of arc)

विक्षिप्त (having celestial latitude, deviated from the ecliptic)

विक्षेप (celestial latitude, latitude of the Moon or a planet), 258-59, 320-21, 327-29

विक्षेपचलन (=अयनचलन) (precession of the equinoxes), 314

विक्षेपमण्डल (=विमण्डल) (orbit of a planet)

विनाडिका (=विनाडी, विघटिका) (one-sixtieth of a *nāḍikā*, 24 seconds)

विमर्दार्ध (half total obscuration in an eclipse), 300ff.

विलिप्ता (=विकला) (second of arc)

विवर (difference)

विशेष (difference)

विश्लेष (difference)

विषम (odd)

विषुवच्छाया (=विषुवद्भा) (equinoctial shadow, *i.e.*, midday

shadow of a 12-digit gnomon when the Sun is at the equinox), 154, 190

विषुवज्जीवा (-ज्या) (= अक्षज्या) (Rsine of latitude)

विषुवत् (-द्वितय), (equinox, vernal, on March 21st, and autumnal, on Sept. 23rd), 154, 190, 248

विषुवत्कर्ण (hypotenuse of equinoctial shadow)

विषुवच्छा—See विषुवच्छाया

विषुवन्मण्डल (celestial equator), 193

विष्कम्भ (1. diameter), 257 ; (2. the first of 27 daily *yogas*, being Sun *plus* Moon), 171, 319

वृत्त (circle), 80ff.

वृत्तकेन्द्र (-नेमि) (centre of a circle), 81ff.

वृत्तपरिधि (circumference), 81ff., 101ff.

वैधृत (the type of *vyatīpāta* which occurs at the time when the sum of the longitudes of the Sun and the Moon amounts to 12 signs or 360 degrees), 311ff.

व्यतीपात (लाट-व्यतीपात), (the time when Sun *plus* Moon equals six signs, *i.e.*, 180°), 311ff.

व्यवकलित (subtraction), 22

व्यास (diameter), 80ff, 118

व्यासार्ध (semi-diameter, radius), 80ff.

शङ्कु (1. gnomon) ; (2. 12-digit gnomon); (3. *Mahāśaṅku* or great gnomon, the perpendicular dropped from the Sun to the earth-line, or the Rsine altitude), 186ff.

शङ्कुकोटि (complement of altitude or zenith distance)

शङ्क्वग्र (north-south distance of the rising or setting point from the tip of the shadow, *i.e.*, *agrā* ± *natijyā* ; distance of the planet's projection on the plane of the horizon from the rising-setting line), 193, 210ff.

शर ('arrow', Rversed sine), 104ff., 118, 145ff.

शिष्ट (=शेष) (remainder in an operation)

शीघ्र (See शीघ्रोच्च)

शीघ्रकर्ण (hypotenuse associated with *śīghrocca* ; geocentric radius vetcor), 161-62

शीघ्रकर्म (*śīghra* operation in planetary computation)

शीघ्रपरिधि (epicycle of the equation of conjunction)

शीघ्रवृत्त (*śīghra* epicycle), 159-61

शीघ्रोच्च (higher apsis of the epicycle related to the equation of conjunction), 161-62

APPENDIX IV

GENERAL INDEX

[*Note* : Roman numerals refer to the pages of the Introduction and Arabic numerals to the pages of the body of the book. References to footnotes are indicated by '*n*' added to page numbers. For Technical terms in Sanskrit, see *Appendix II*, above. References from the *Yuktidīpikā* section (pp. 1-288) mostly imply 'rationales', while those from the *Laghuvivṛti* section (pp. 289-343) to 'computations' only. These two expressions have, therefore, to be taken as implied in the relevant references.]

ADDENDA ET CORRIGENDA

Page	*Line* (—=from below)	*For*	*Read*
ix	—6	ग्रहेषु चरस्य	ग्रहे चरादि
	,,	difference	difference etc.
x	—8	स्फुट:	स्फुटगति:
	,,	True Sun	True rate of motion
xxxii	10	to work	to this work
	16	It is goes	It goes
xxxiii	—11	*Sidahānta-*	*Siddhanta-*
xxxiv	10	विवित्वार्यभट	विवितार्यभट
xlii	—7	मासतिल्	मासत्तिल्
lxvii	—6	corroborated Acyuta	corroborated by Acyuta
lxix	—12	*Śabdārthdīpika*	*Śabdārthadīptkā*
19	5	गत:	गता:
26 After	2	Add heading : गणितस्य वृद्धिक्षयात्मकत्वम् ।	
27 ,,	5	,, गुणकर्मवासना	
	—5	259-295	259-262
29	3	स्यल्पेष्ट	स्वल्पेष्ट
30	11	हारावृत्ति	हारावृत्ति
	13	स्थाानि	स्थानि
55	—6	ास्माद्	तस्माद्
58	11	वृढवासर एवैक: पूर्वाक्ता	वृढवासर एवैक: पूर्वोक्तो
63	11	क्षेत्रयो	क्षेपयो
	—9	महाकायप्रनुरू	महाकायप्रनुर्
64	—1	Delete fn. 1	
	—15	शेषं द्वय	शेषद्वय
72	—8	प्राग्वेश समरेखात:	प्राग्वेशे समरेखात:
78	—1	मार्गो	मार्गो
103	12	कुञ्अर	कुञ्जर
117	9	इष्टज्याशर etc.	इष्टज्यानयने 'विद्वान्' इत्यादि-माधवोदितविधि:
118 Before	1	Add heading : इष्टशरानयने 'स्तेन: स्त्री'ति माधवोदितविधि:	
,,	—6	,, ,, इष्टव्यासस्य परिधिसाधनम्	
120	1	ज्याचापानयनं	सूक्ष्मज्याचापानयनम्

Page	*Line*	*For*	*Read*
121	8	दोर्गणे	दोर्गुणे
	—7	कोटया	कोट्या
151	10	भवति, स्पष्टा	भवति स्पष्टा,
155	6	ग्रहेषु चरस्य	ग्रहे चरावि-
166	11	सर्वक्ष	सर्वत्र
171	9	तत्कालकरणम्	Read this after the next line
	—11	तत्कालविष्कम्भ:	तत्कालयोग:
189	3	अधऊध्व	अधऊर्ध्वं
191	3	छायाशङ्कु	छाया शङ्कु
209	1	छायया दिगवगमनम्	छायाभुजानयनं दिगवगमनं च
212	9	वृत्तत्रयं, तेन	वृत्तत्रयं तेषु
	—3	Delete fn. 2	
215	11	द्वितोये	द्वितीये
	15	शङ्क	शङ्कु
216	6	सममण्डलशङ्कु	सममण्डलग: शङ्कु
217	1	उन्मण्डला	उन्मण्डलाद्
219	7	नत्यौ	नतौ
	—8	शङ्कुनत्यानयन	शङ्क्वानयन
225	1	-क्रम:	-क्रमौ
229	4	-राशाग्रा, कोटि	-राशाग्राकोटि
247	7	मध्याह्नलग्न	मध्यलग्न
253	—6	इन्द्वो-	इन्द्वो
289	5	दृक्क्षेत्रपलग्नात्	दृक्क्षेपलग्नात्
293	1	त्रिजीवाघ्नामाद्य	त्रिजीवाघ्नमाद्य
301	3	गतिमेवाप्तं	गतिभेदाप्तं
307	12	लक्ष्यये	लक्ष्यते
309	13	विधोमार्ग:	विधोर्मार्ग:
	15	विधोमार्गे	विधोर्मार्गे
311	8	प्रवशितम्	प्रदर्शितम्
318	13	बिम्बफला:	बिम्बकला:
319	1, 10	विष्कम्भ...र्धानां	व्यतीपातयोगान्त्यार्धस्य
321	6	भुजङ्गाङ्गा	भुजङ्गाङ्ग
	—7	शीघ्र	शीघ्र
327	11	चन्द्रन्य	चन्द्रस्य

333 Before l, 11. Add heading : सितमानम्

CHAPTER XI

SIDDHĀNTADARPAṆA OF NĪLAKAṆṬHA SOMAYĀJI

('MIRROR OF THE LAWS OF ASTRONOMY')

With Auto-commentary

Critically edited with

Introduction, Translation and Two Appendices

CONTENTS

INTRODUCTION

The *Siddhānta-darpaṇa* of Nīlakaṇṭha Somayāji (born 1443) critically edited here with his own commentary, is a short but important work of this noted astronomer of Kerala, which enunciates the basic astronomical constants as verified and adopted by him. It also sets forth certain other matters including the theory of epicycles as understood in Hindu astronomy. The textual verses with translation had been issued by the present writer, more than twenty years ago, through the pages of the well-known Indological journal, the *Adyar Library Bulletin*, 19 (1955) 327-68. The special significance of the present edition consists in its being embellished with the elaborate commentary on the text by the author himself.

Manuscript material

The edition presented in the following pages is based on seven manuscripts of the text, designated **A** to **G**, one of the manuscripts containing the commentary as well, all inscribed in the Malayalam script on palmleaf.

A. Ms. No. 475-D of the Kerala University Oriental Research Institute and Manuscripts Library, Trivandrum. It is an old and reliable manuscript found in a codex of more than a dozen astronomical works. The codex is dated *sevyo dugdhābdhitalpaḥ*, *viz.*, the 16,99,847th day of the Kali era, which works out to A.D. 1551, just a few years after the death of the author in about A.D. 1545.

B. Ms. 5867-C of the above Library. The manuscript carries a comparatively pure text, and is included in a codex of several astronomical works. A modern paper transcript of this manuscript in Devanagari script is available in the Madras Government Oriental Mss. Library, No. R. 5151 (*b*).

C. Ms. No. C. 1869-C of the Curator's Collection of the Kerala University Mss. Library. This manuscript is much injured and the rectos of the folios are broken away. The beginning of the manuscript is lost and the work is available only from verse 13.

D. Ms. No. C. 1024-F of the Curator's Collection of the above Library. This is a well preserved manuscript found in a codex of

astronomical works. The codex is dated the 16,99,847 th day of Kali, being the same date as that of **A**, but the codex is not related to it, since it presents several substantial variants.

E. Ms. No. 8358-I of the above Library. This manuscript contains the full text of the work and is in good preservation, but abounds in scribal errors.

F. Ms. No. 6302 of the India Office Catalogue of Sanskrit and Prakrit Manuscripts (Vol. II, by Keith, p. 775). This is a well preserved manuscript and presents a generally correct text.

G. Ms. No. 975 of H. H. The Maharaja's Palace Library, Trivandrum, now preserved in the Kerala Univ. Library noted above. This manuscript contains the text as well as the commentary edited here. The manuscript is well preserved and is generally correct, but unfortunately certain portions in it are lost, including the first leaf and portions of the text and commentary of verses 7 *c* to 16 and 28-32. The codex contains, in continuation, another discursive work of Nīlakaṇṭha himself, but which is incomplete and is given the title *Grahaṇādigrantha* on the basis of its contents.

Relationship of the Manuscripts

An examination of the variant readings preserved in the above manuscripts makes it possible to classify them into two groups : Mss. **A, B, C** on the one hand and Mss. **D, E, F** on the other, particularly in view of the following considerations :

(i) an entirely different reading for the latter half of verse 4 ;

(ii) substantial variants in the first half of verse 7, and

(iii) the first half of verse 25 being transposed after 26, in the second group, with the verse numbers correspondingly adjusted in the manuscripts.

The text and commentary in Ms. **G** agrees with the second group as regards (i), and with the first group as regards (ii) and (iii). It may be noted that the author himself suggests variant readings to his text in the commentary, *e.g.*, *niyate* to *nīyatām* in verse 27, the two expressions indicating slightly different meanings.[1] The closeness of the

1. It is interesting to note that the reading *nīyatām* is the one adopted by the author when he quotes the verse in his *Bhāṣya* on the *Āryabhaṭīya* on *Kālakriyā* 18-21 (Edn. Trivandrum, 1931, p. 46).

date of the manuscripts presenting the variants with the lifetime of the author and the variants trying to improve upon one another, would tend to suggest that the variants in the two groups have originated from the author himself who has revised his own text.

Appendix I. Ms. No. 5867-I of the Kerala University Mss. Library referred to above, occurring in the same codex which contains Ms. **B** of the text. The text preserved is generally correct and free from errors.

Appendix II. A, Ms. No. C. 2740 (folio 98 *b*) and **B**, Ms. No. C. 2314 (folio 74) of the same Library. Both these are palmleaf manuscripts in Malayalam script, the latter being worm-eaten and considerably damaged. The two manuscripts are closely related and appear to have descended from a common original. The main work contained in the codices is the *Karaṇapaddhati* of Putumana Somayāji and the present work is found amongst the miscellaneous matter inscribed at the close of the manuscripts.

Authorship of Siddhānta-darpaṇa and Commentary

Nīlakaṇṭha quotes, in his *Āryabhaṭīya-Bhāṣya*, from an earlier work of his under the name *Darpaṇa*. He says :

अविशेषणं विना सकृत्कर्मणा वापि मन्दकर्णः साध्यः। तच्च मया दर्पणे सूचितम् —

कर्णवृत्तांशबाह्वाद्यैर्मन्दे कक्ष्यैव नीयताम् ।[1]

The passage quoted forms the second half of verse 27 of *Siddhānta-darpaṇa* edited here (see p. 24). Elsewhere in the same work, he quotes verses 22-24a of *Siddhānta-darpaṇa* with the prefatory statement :

अत एव मया सिद्धान्तदर्पणे सर्वत्र स्फुटन्यायातिदेशः प्रदर्शितः सामान्येन— 'ज्ञातभोगग्रहं वृत्तं' etc.[2]

In fact, the colophons to the several Text manuscripts of the work used in this edition read as follows, indicating the authorship of the work :

इति गार्ग्य-केरलसद्ग्राम-नीलकण्ठ-विरचितं सिद्धान्तदर्पणं समाप्तम् ॥ (p. 32).

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1. *Āryabhaṭīya* with the *Bhāṣya* of Nīlakaṇṭha, Pt. ii, *Kālakriyāpāda*, Trivandrum, 1931, *Trivandrum Skt. Series*, (*TSS*), No. 113, p. 46.

2. *Op.cit.*, Pt. iii, *Golapāda*, Trivandrum, 1957, (*TSS* 185), pp. 18-19.

"Thus ends the *Siddhānta-darpaṇa* by Nīlakaṇṭha of the Gārgya-gotra, (resident) of Keralasad-grāma." This leaves no doubt about the name of the author, his descent and his provenance. This is reinforced by the words of the scribe Śaṅkara of one of the Text manuscripts which reads as follows (see p. 32, below) :

गार्ग्य-केरलसद्ग्राम-नीलकण्ठेन निर्मितम् ।
सिद्धान्तदर्पणं शास्त्रमलिखत् शङ्कराभिधः ।।

However, the only manuscript of the commentary available to us and which forms the basis of the present edition thereof, is unfortunately, incomplete, with its beginning and end lost and with no specific mention of its authorship anywhere in it. But, besides the close similarity of the style and diction of the commentary of the *Siddhānta-darpaṇa* with that of Nīlakaṇṭha's *Āryabhaṭīya-Bhāṣya*, there are ample circumstantial evidences to identify its author as Nīlakaṇṭha himself.

In his works Nīlakaṇṭha often refers to his teacher Dāmodara (on him see below, pp. xviii-xix) and quotes him. *Cf.* the passages :

1. निबद्धं च तत् तदेव अस्मद्गुरुभिः पञ्चभिरुपजातिभिः—'अर्कस्फुटेन' etc.[1]
2. कालक्रियापादे प्रकारान्तरेण 'चन्द्रबाहुफलवर्ग'त्यादिना श्रीमद्-दामोदराह्वयादस्मद्गुरुमुखोद्गतेन श्लोकेनोक्ता ।[2]
3. यद्वा यत्र यत्र त्रिज्यया कर्णेन वा कर्म कार्यं स्यात् तत्र तत्र विपरीतकर्मणानीतेन कक्ष्याव्यासार्धेन त्रिज्यातुल्येन स्फुटकक्ष्याव्यासार्धेन च कर्म कार्यम् । तच्चोक्तमस्मदाचार्यैः —

'सर्वत्र विष्कम्भदलं श्रुतौ वा व्यासार्धके स्याद् विपरीतकर्णः ।'[3]

The third of the above passages occurs in identical strain in the Commentary of the *Siddhānta-darpaṇa* also, pointing to the identity of the authorship of the two commentaries : *Cf.* तत्र त्रिज्ययोक्तं कर्म विपरीतकर्मानीतेन कार्यम्, कर्णोक्तं कर्म त्रिज्यया च । तदपि—

'सर्वत्र विष्कम्भदलं श्रुतौ वा व्यासार्धके स्याद् विपरीतकर्णः ।'
इति अस्मद्गुरुणा उक्तम् । (See below, p. 30).

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1. *Op.cit.*, Pt. ii, p. 48.
2. *Grahaṇādigrantha*, Ts. p. 61.
3. *Āryabhaṭīya-Bhāṣya, op. cit.*, Pt. ii, pp. 46-47.

Again, Nīlakaṇṭha frequently refers in his works to his *Parama-guru* Parameśvara and to his views, experiments and findings.[1] There is, however, a characteristic experimental finding of Parameśvara, which Nīlakaṇṭha refers to in his *Grahaṇadi-grantha* : **अयनचलनांशाः ··· अस्मत् (परम)आचार्येण 'रसरामेष्वब्धि' (४५३६) मिते कल्यब्दे पञ्चवशभागाः पूर्णाः इति परीक्ष्य निर्णीतम् ।**[2] The *Siddhānta-darpaṇa-vyākhyā* reads, in a very similar situation : **तवा अयनचलनांशाः धनात्मकाः पञ्चवशसंख्या बभूवुः ।** ··· **यतो भार्गव-परमेश्वराचार्येण अस्मत्परमगुरुणा 'चलांशास्त्वम्' (४५३६) इति कल्यब्वे परीक्ष्य पञ्च-वशांशपूर्तिनिर्णीता ।** (p. 17). The identity of authorship of the above two passages is patent. In consideration of the above, it can be stated with definitude that Nīlakaṇṭha, author of *Āryabhaṭīya-Bhāṣya*, is the author also of the *Siddhānta-darpaṇa-vyākhyā*.

Contents of Siddhānta-darpaṇa

The importance of *Siddhānta-darpaṇa* lies in the fact that the author presents herein the astronomical constants as verified through his own observations and investigations. The passages expressing these constants having been adopted and commented upon by the author in his commentary, which latter happens to be one of his last works (see below, p. xxv), it could be taken that the values of the constants as given herein are the final figures accepted by Nīlakaṇṭha.

In the First Part of the work called *Upadeśa-bhāga* (Theory Section), the author enunciates in twenty couplets (2-21), his view on the number of revolutions of the planets, their higher apses (*mandocca*) and ascending nodes (*śighrocca*) during a definite period of time, the epicycles of the equations of the apses (*manda-paridhi*) and of conjunctions (*śīghra-paridhi*), the measure of the aeons (*yuga-s*), the velocity of the planets, the measure of the diameters of the Moon and the Sun, the position of the city of Avantī, the situation of the ecliptic (*apakrama-vṛtta*), and the conception of the epicycles.

In the Second Part called *Nyāya-bhāga* (Practical Section) (verses 21-31), are set forth the eccentric and orbital circles (*prati-maṇḍala* and *kakṣya-maṇḍala*), the sines etc. of the angles measured

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1. *Cf.*, *Āryabhaṭīya-Bhāṣya*, Pt. i : *Gaṇitapāda* (Trivandrum, 1930), (*TSS* 101), p. 180 ; Pt. ii : *Kālakriyāpāda*, pp. 63, 64 ; Pt. iii : *Golapāda*, pp. 13, 79, 151, 154, 155-58.

2. *Grahaṇādigrantha*, Ts, p. 65.

on these circles, the geocentric position of the planets, declination and its measurement. The author also gives his views on the occurrence of the *vyatīpāta-s*, the extent of the lunar crescent and the data on which eclipses are to be calculated.

Appendices

The two Appendices are later anonymous compilations, the purpose of which is to give, in the more popular *kaṭapayādi* notation of expressing numbers, the figures given according to the *bhūta-saṅkhyā* system in the text. Besides this, Appendix I gives some further useful information, *viz.*, the actual position of the planets at the beginning of the Kali era as calculated with the constants enunciated in the *Siddhānta-darpaṇa*, the position of the higher apses and the ascending nodes of the planets at the end of Kali year 4800 (A.D. 1697-98) and the geocentric positions of the planets at a definite date expressed by the chronogram *anūnaśaśiseyaḥ* (17,55,000) which works out to A.D. 1704. The last number is a constant or 'partial' (*khaṇḍa*) intended to be subtracted from the number of Kali days of any later date on which the position of the planets is to be calculated. It would be natural to suppose from this that Appendix I was composed after the date of this *khaṇḍa, viz.*, A.D. 1704.

The Commentary

In line with his *Bhāṣya* on the *Āryabhaṭīya*, Nīlakaṇṭha's commentary on the *Siddhānta-darpaṇa* is elaborate and discursive. Alongside explaining the text proper, it introduces related topics by way of background, illustration and rationalisation. Often, the commentary dilates into verse, a practice with Kerala astronomers like Parameśvara.[1] This feature is found also in Nīlakaṇṭha's *Āryabhaṭīya-Bhāṣya*.

Nīlakaṇṭha's discursions are often highly instructive. An instance in point is his detailed analysis of the mental working of a mathematician who proceeds to derive the relation between the sides and

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1. See Parameśvara's super-commentary *Siddhāntadīpikā* included in the Edn. of *Mahābhāskarīya* of Bhāskarācārya with commentaries, by T.S. Kuppanna Sastri, Madras, 1957, (*Madras Govt. Or. Series*, No. 130).

the hypotenuse of a right-angled triangle (pp. 22-24, below). In the course of this discursion, he makes a mention also of the two methods of approach for solving mathematical problems, *viz.*, that of logical reasoning and that of demonstration on the board. He adds that one should first try the method of demonstration, for logical reasoning is limited, endless and sometimes inconclusive (*alpa-viṣayatvāt, ānantyād, kvacidapyaviśrānteś ca*, p. 23). Equally instructive are the method of constructing the armillary sphere, the defining of the situation of *rāśi-s* therein (p. 14), and the exposition of the computation of the geocentric position of the planets (pp. 25-31).

The following observations of Nīlakaṇṭha are noteworthy :

1. *Ayanāṁśa* (measure in minutes of the precession of the equinoxes) should be derived by observation, if it has to be accurate (p. 17).

2. The use of *Trairāśika* (Rule of three) is justified even in computations concerning moving bodies, since the factors involved are considered only for specific moments at which they might be taken as stationary (p. 25).

3. In astronomical computation it does not make any difference whether the eastward motion of the earth or the westward motion of the planets are taken because the motion is relative (p. 5).

4. The *Bhagola* (*Rāśigola*, ecliptic sphere) revolves as a whole and not *Vāyugola* (having the *Ghaṭikāmaṇḍala* or Celestial equator as one of its great circles) ; thus the relative distances between the stars remain constant, from which other results follow (pp. 16-17).

5. The *vikṣepa* (celestial latitude) of stars beyond five or six degrees on either side of the ecliptic have to be observed and determined by means of instrumental observation, for they cannot be gauged in relation to the planets, which all lie within the said limit (p. 16).

It is unfortunate that the only available manuscript of the commentary is incomplete. The loss is especially significant, for the last portion should have contained the elucidatory examples about

which the author makes a mention elsewhere : *cf.*, *etat sarvam upariṣṭād udāharaṇena spaṣṭīkariṣyate* (p. 22).

Nīlakaṇṭha, the Author

Our author is generally referred to with the title *Somayājī*, *Somasut*, *Somasutvan* or *Comātiri*, the last being the Malayalam derivative of the Sanskrit word. A detailed colophon occurring at the end of his *Bhāṣya* on the *Gaṇitapāda* of the *Āryabhaṭīya*, contains a good deal of information about him : इति श्री-कुण्डग्रामजेन गार्ग्यगोत्रेण आश्वलायनेन भाट्टेन केरलसद्ग्राम-गृहस्थेन श्री-श्वेतारण्यनाथ-परमेश्वरकरुणाधिकरणभूतविग्रहेण जातवेदः-पुत्रेण शङ्कराग्रजेन जातवेदोमातुलेन दृग्गणितनिर्मापकपरमेश्वरपुत्र-श्री-दामोदरात्तज्योतिषामयनेन रवित आत्तवेदान्तशास्त्रेण सुब्रह्मण्यसहृदयेन नीलकण्ठेन सोमसुता विरचितविविध-ग्रन्थेन दृष्टबहूपपत्तिना स्थापितपरमार्थेन कालेन शङ्कराद्य(?य) निर्मिते श्रीमदार्यभटसिद्धान्त-व्याख्याने महाभाष्ये etc.[1]

Personal details

The above-quoted passage informs that Nīlakaṇṭha belonged to the Gārgya gotra,[2] was a follower of the *Āśvalāyana-sūtra* of the *Ṛgveda* and was a *Bhāṭṭa*. He was the son of Jātavedas and had a younger brother named Śaṅkara. He had an uncle Jātavedas by name and a close friend Subrahmaṇya. He was a performer of the *Soma* sacrifice. He had composed several works on astronomy, in which subject he had made deep and extensive investigations, a fact which is well borne out by his available works.

Some more personal details about Nīlakaṇṭha seem to be forthcoming from a Malayalam work entitled *Laghurāmāyaṇa*.[3] This work describes itself as a work of Rāma, son of Nīlakaṇṭha of the Gārgya-gotra and resident of Kuṇḍagrāma. *Cf.*, the colophon at its end : इति कुण्डग्रामजेन गार्ग्यकुलतिलकेन श्री-नीलकण्ठात्मजेन आर्याम्बा-गर्भसम्भवेन मन्वादिस्मृतिमर्मज्ञ-संस्कृत-द्राविड-भाषा-त्रय-पारीणस्य दक्षिणामूर्तिनाम्नोऽग्रजेन रामेण विरचितं श्रीरामायणं प्रबन्धम् ।

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1. *ABh. Gaṇita*, Ed., *TSS*, No. 101, (Trivandrum, 1930), p. 180.

2. Generally the term *Gārgya* is affixed to his name in references.

3. Ed. P.R. Menon, *Tuñcattu Granthāvali*, No. 3, Tuñcattu Kāryālayam, Chittoor, 2nd edn., 1931.

This Nīlakaṇṭha is identified by the editor of the work with our author.[1] If this identification is correct, Nīlakaṇṭha's wife was named Āryā, and he had two sons Rāma and Dakṣiṇāmūrti, the latter of whom was well versed in the Dharmaśāstras and learned in the three languages, Sanskrit, Tamil and Malayalam. The great Malayalam poet Tuñcattu Ezhuttacchan is said to have been a student of Nīlakaṇṭha. Nīlakaṇṭha is also said to have composed, at the request of a friend, a panegyric in Malayalam on the Goddess Pārvatī, the presiding deity of the temple of Ūrakam in Cochin, in order to ward off the predicted premature death of that friend's daughter.[2] The authenticity of the above work and the sources of the information are, however, not quite certain, and corroborative evidences have to be found before accepting the above statements.

Birth-place and Family

Nīlakaṇṭha hailed from Tṛ-k-kaṇṭi-yūr (Sanskritised into Śrī-Kuṇḍa-pura or Śrī-Kuṇḍa-grāma), near Tirur, S. Rly., Ponnani taluk, South Malabar, a famous seat of learning in Kerala during the middle ages. The name of his *Illam*, as the house of a Nampūtiri brāhman is called, was *Keḷallūr* (sometimes spelt also as *Kerallūr* and *Keḷannūr*), Sanskritised into *Keraḷa-sad-grāma* corresponding to the Malayalam word Keraḷa-nall-ūr.[3] Nīlakaṇṭha's house is identified as the present Eṭamana Illam, situated a little to the south of the local temple.[4] It is stated that Nīlakaṇṭha's family became extinct and that the family property was inherited by the nearest relations, *viz.*, the Eṭamana family.[5]

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1. *Vide* P.R. Menon in his article 'Tuchattu Ezhuttacchan' in the Malayalam monthly *Tunchattu Ezhuttacchan*, 3 (1952-53) 127-35.

2. *Ibid.* This stotra is published in a collection of stotras in Malayalam script entitled *Stavaratnamālā*, Pt. 1.

3. It may be noted that in the expression *Gārgya-Kerala* prefixed to the author's the word *Kerala* refers to the name of his house and not to the state, as is sometimes taken.

4. *Cf.*, Vatakkumkur Rajaraja Varma, *History of Skt. Lit. in Kerala*, vol. I, Trivandrum, 1938, p. 384.

5. I am thankful for this information to the late Sri Rama Varma Maru Thampurān, Chalakkudi (Cochin).

Nīlakaṇṭha's favourite deity was Lord Śiva installed in the famous temple at Tṛpparaṅṅoḍ (Sanskrit Śrī-Śvetāraṇya) near his village ; *cf.* **श्री-श्वेतारण्यनाथ-परमेश्वर-करुणाधिकरणभूतविग्रहेण**, in the colophon to the *ĀBh. Bhāṣya* quoted above (p. xiv).

Śaṅkara, the Brother, and Netranārāyaṇa, the patron

Nīlakaṇṭha refers to his younger brother Śaṅkara in several places in the *ĀBh.Bhāṣya.* Śaṅkara too seems to have been well versed in astronomy and followed his elder brother's studies. Thus, after describing some method on the Rule of three (*Trairāśika*) in his *ĀBh.Bhāṣya, Gaṇita* 26, Nīlakaṇṭha says how his brother who was teaching at the house of his patron explained to the latter some of those theories : *cf.*, **अत्र केषांचिद् युक्तय: पुन: अस्मदनुजेन शङ्कराख्येन तत्समीपे अध्यापयता वर्तमानेन तस्मै (नेत्रनारायणाय) प्रतिपादिता: ।** (*TSS* 101, p. 156).

Nīlakaṇṭha observes at the close of the *Bhāṣya* on the *Golapāda* that he was entrusting the *Bhāṣya* to Śaṅkara for its proper propagation. Thus, just before the final colophon, Nīlakaṇṭha says : **एवमिदम् अस्माभिर्यथामति व्याख्यातम् ।**

नम: स्वयम्भुवे तस्मै यत्प्रसादादिदं कृतम् ।
नमो भगवते तस्मै श्रीमदार्यभटाय च ॥

शिष्यं तत्त्वेन विचार्यार्यभटसूत्रभाष्यमिदम् ।
यदि स न्यायालिप्सेदस्मै दातव्यमेव शङ्कर ते ॥

इति गोलपादव्याख्यानं समाप्तम् ॥

(*TSS* 185, p. 164)

That Nīlakaṇṭha was intimately connected to and was patronised by Kauṣītaki Āḍhya Netranārāyaṇa, known locally as Āzhvāñceri Tamprākkal, the religious head of the Nampūtiri brāhmans of Kerala, is known from several references in his writings. It is also clear that the patron had great esteem for Nīlakaṇṭha's erudition in astronomy, in which subject he too was interested and used to discuss difficult points with Nīlakaṇṭha. Thus, in the discussion on the calculation of the motion of planets (*ĀBh., Kala.*, 22-25), Nīlakaṇṭha says :

कर्णभुक्ति: स्फुटेत्यत्र व्याख्याने पारमेश्वरे ।
व्यासार्धाप्तं कोटिवर्गात् कर्येणादावृणं धनम् ॥

कोटयां तदूनयुग्ध्यासदलं गतिविधौ श्रुतिः ।
प्रकारान्तरमाहैवं सूक्ष्मभुक्तिप्रसिद्धये ॥
गुरूणां मे पितात्रापि स्थौल्यान्मत्सरिणोविते ।
परमेश्वर-तच्छिष्या नैव वेलागतिं विदुः ॥
इति कौषीतकी श्रुत्वा नेत्रनारायणः प्रभुः ।
मह्यं न्यवेदयत् तस्मै तदेवं प्रत्यपादयम् ॥
(*TSS* 110, p. 63)

Again, in the long discussion on the calculation of the apparent position of celestial bodies (*ĀBha.*, *Kāla.*, 17-21), speaking on a method to derive the *sakṛt-karṇa*, our author says : अन्यदपि कर्म अस्माभिरुपन्यस्यमानं श्रुत्वा आढ्येन कौषीतकिना अनुष्टुभा निबद्धम्—

स्वोच्चोनमध्यमार्कस्य भुजाज्याघ्ना त्रिजीविका ।
स्वोच्चहीनस्फुटार्कस्य दोर्ज्याभक्ता श्रुतिर्भवेत् ॥ इति ॥
(*ISS* 110, p. 47)

This would indicate the intimacy that existed between Nīlakaṇṭha and his patron and the common interest that bound them together. On the compilation of the *ĀBh. Bhāṣya,* Nīlakaṇṭha observes in one place : यन्मयात्र केषांचित् सूत्राणां तद्युक्तीः प्रतिपाद्य कौषीतकिना आढ्येन नारायणाख्येन व्याख्यानं कारितम्, अतस्तदेवात्र लिख्यते । (*TSS* 101, p. 113), Again, at another context, he remarks : इतीदं प्रथमे वयस्येव वर्तमानेन मया द्वितीयवयसि स्थितेन कौषीतकिना आढ्येन कारितम् । ·········तस्मिन् स्वर्गते पुनः······व्याख्यानमारब्धम् । (*TSS* 101, p. 156).

It is clear from the above that the credit of enthusing Nīlakaṇṭha in his investigations, and, in fact, to have prompted him to write his *ĀBh.Bhāṣya,* goes to Netranārāyaṇa,[1] the members of whose family are

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1. Even with regard to Nīlakaṇṭha's *Tantrasaṅgraha,* its introductory verse,

हे विष्णो निहितं कृत्स्नं जगत् त्वय्येव कारणे ।
ज्योतिषां ज्योतिषे तस्मै नमो नारायणाय ते ॥

has a veiled reference to his patron (Netra)-Nārāyaṇa at whose instance that work too seems to have been written.

known all through the annals of Kerala history to have been good scholars and, at the same time, patrons of scholarship.

Ravi and Dāmodara, the Teachers

Nīlakaṇṭha informs us in his *ABh.Bhāṣya* that he studied Vedānta under Ravi, *cf. Ravita atta-Vedānta śāstreṇa,* (*TSS* 101, p. 180). That Ravi was well versed also in *jyotiśśāstra* and that Nīlakaṇṭha imbibed some of his knowledge in astronomy from Ravi is clear from the introductory verse to Nīlakaṇṭha's *Siddhānta-darpaṇa*, edited here, where his teacher has been mentioned by *double entendre* :

श्रीमद्दामोदरं नत्वा भगवन्तं रविं तथा ।
यत्प्रसादान्मया लब्धं ज्योतिश्चरितमुच्यते ।।

A work on astrology, *Ācaradīpikā*, which is a detailed commentary, in verse, on *Muhūrtāṣṭaka*, is ascribed to this Ravi.[1]

The teacher of Nīlakaṇṭha who actually initiated him into the science of astronomy and instructed him on the various principles underlying mathematical calculations was Dāmodara, son of the Kerala-*Dṛggaṇita* author Parameśvara,[2] of the Bhārgava-gotra and resident of the village of Ālattūr (Sanskritised into Aśvattha-grāma) which was situated quite near Nīlakaṇṭha's own village. In his *ĀBh.Bhāṣya*, as also in his other works, Nīlakaṇṭha reverentially refers to his teacher and his studies under him. He speaks of how even as a boy he stayed with his *guru* at the latter's residence prosecuting his studies ; *cf.* मया गुरुकुले वसता बाल्य एव etc. (*ĀBh.Bhāṣya, TSS* 110, p. 48). He also refers, often, to his teacher's views and quotes him ; *cf.* प्रकारान्तरेण 'चन्द्रबाहुफलवर्ग'त्यादिना श्रीमद्-दामोदराह्वयास्मद्-गुरुमुखोद्गतेन श्लोकेनोक्ता, तद्युक्ति: etc. (N's *Grahaṇādigrantha*[3] Ts. p. 61) ; तच्चोक्तमस्मदाचार्यैः (*ĀBh. Bhāṣya, TSS* 101, p. 47) ; निबद्धं च तत् तदेव अस्मद्गुरुभि: पञ्चभिरुपजातिभि: 'अर्कस्फुटेनानयनं प्रकुर्यात्' etc. (*ibid.*, p. 48) ; तदपि—

"सर्वत्र विष्कम्भदलं श्रुतौ वा व्यासार्धके स्याद् विपरीतकर्ण: ।"

इत्यस्मद्गुरुणोक्तम् (*Siddhānta-darpaṇa-vyākhyā*, on verse 27 (p. 30, below).

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1. Ulloor, *Kerala Sahitya Caritram*, vol. II, Trivandrum, 1954, p. 114. For a Ms. of this work see Kerala Uni. Mss. Lib., No. 3336-B.

2. *Cf.* the detailed colophon quoted above, pp. xiv.

3. On this work, see below, p. xxii-xxiii.

Similar quotations and other references, which Nīlakaṇṭha and later authors make, proclaim Dāmodara not only to be a prominent astronomer of the times but also as the author of erudite works on the subject, mansuscripts of which, are yet to come to light.

Nīlakaṇṭha followed in the footsteps of Parameśvara, founder of the *Dṛggaṇita* system of astronomy in Kerala and one of the foremost astronomers of the land. For him Parameśvara was not only the revered father of his *Guru* but was also his *Parama-guru*, by which term he generally refers to him in his works ; *cf.*, **यतो भार्गव-परमेश्वराचार्येण** अस्मत्परमगुरुणा **'चलांशास्त्वं'** (4546) **इति कल्यब्दे परीक्ष्य पञ्चवशांशपूर्तिर्निर्णीता ।** etc. (*Siddhāntadarpaṇa-vyākhyā*, verse 18, p. 17 below) ; अस्मत्परमगुरुणापि सिद्धान्तदीपिकायाम् **एतत् प्रतिपादितम् ।** *ĀBh.Bhāṣya, Golapāda*, verse 3).

Works of Nīlakaṇṭha

Nīlakaṇṭha has written several works which reflect his deep study of and ripe scholarship in astronomy, embodying the results of his investigations on the subject and interpreting the science lucidly. A mention of his works may, advantageously, be made here :

1. *Golasāra*[1] ('Quintessence of spherical astronomy') in three *paricchedas*, embodying the basic astronomical elements and procedures.

2. *Siddhāntadarpaṇa*, a short work in thirty-two *anuṣṭubhs*, enunciating the astronomical constants with reference to the ***Kalpa*** and specifying his views on the main astronomical concepts and topics, being the work edited here.

3. *Candracchāyāgaṇita*, or merely *Chāyāgaṇita*, under which title it is sometimes cited, a short work in thirty-two verses on the methods for the calculation of time from the measurement of the shadow of the gnomon cast by the Moon and vice-versa.[2]

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1. Cr. edn. with Translation, by K. V. Sarma, V.V.R. Institute, Hoshiarpur, 1970.

2. Critically Ed. with the author's own commentary, Translation and Appendices, by K.V. Sarma, Hoshiarpur, 1976 (***Panjab Univ. Indological Series***, No. 6).

4. A commentary on the *Candracchāyāgaṇita*, added to the edition of the text (see fn. 2, previous page).

5. *Tantrasaṅgraha*,[1] divided into eight chapters comprising 432 verses. This is a major work of Nīlakaṇṭha and is an erudite treatise on astronomy. As a work belonging to the *Tantra* class, it takes the commencement of the *Yuga* as the starting point for calculations. In the several chapters, it deals with : I. Astronomical constants and general principles and conceptions. II. Geocentric positions of the planets. III. The Sun's shadow. IV. Eclipses of the Moon and the Sun. V. Specialities in the Sun's eclipse. VI. *Vyatīpāta*. VII. The Phases of the Moon, etc. VIII. Elevation of the lunar horns.

6. *Āryabhaṭīya-Bhāṣya*,[2] an elaborate commentary on the cryptic and *sūtra*-like text of Āryabhaṭa which comprehends in 121 *āryās* the fields of Mathematics and Astronomy. A perusal of the commentary will amply prove that it is no false claim that Nīlakaṇṭha makes when he designates his work as a '*mahābhāṣya*' and explains the method of exposition adopted by him : श्रीमदार्यभटाचार्यविरचितसिद्धान्त-व्याख्याने 'महाभाष्ये' उत्तरभागे युक्तिप्रतिपादनपरे त्यक्तान्यथाप्रतिपत्तौ निरस्तदुर्व्याख्याप्रपञ्चे समुद्घाटितगूढार्थे सकलजनपदजातमनुजहिते निदर्शितगीतिपादार्थे सर्वज्योतिषामयनरहस्यार्थनिदर्शके समुदाहृत-माधवादि-गणितज्ञाचार्यकृत-युक्तिसमुदाये निरस्ताखिलविप्रतिपत्तिप्रपञ्च-समुपजनितसर्व-ज्योतिषामयनविदमलहृदयसरसिजविकासे निर्मले गम्भीरे अन्यूनातिरिक्ते गणितपाद-गतार्यात्रयस्त्रिंशद्व्याख्यानं समाप्तम्। (*TSS* 101, p. 180).

In another context, recalling how he came to write the commentary, Nīlakaṇṭha remarks : मयाद्य प्रवयसा ज्ञाता युक्तीः प्रतिपादयितुं भास्करादिभिरन्यथाव्याख्यातानां कर्माण्यपि प्रतिपादयितुं यथाकथंचिदेव व्याख्यानमारब्धम् । (*TSS* 101, p. 156).

The lucid manner in which the difficult conceptions about the celestial globe and astronomical calculations are made clear, the wealth of quotations, and the results of personal investigations and comparative studies persented herein amply justify the appellation '*Mahābhāṣya*' which Nīlakaṇṭha has given to his work.

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1. Ed. with the commentary *Laghuvivṛti* of Śaṅkara, in *TSS* 188, 1958.

2. Ed. in *TSS* 101, 110, 185 (1930, 1931, 1957).

Nīlakaṇṭha has commented only on the *Gaṇita*, *Kālakriyā* and *Gola-pādas* of the *Āryabhaṭīya*, leaving out the *Gītikāpāda*, which he says is covered by the commentary on the other three sections ; *cf* **तत्रेयं त्रिपाद्यस्माभिर्व्याचिख्यासिता, यतस्तद्व्याख्येयरूपत्वाद् गीतिकापादस्य । एतद्व्याख्यानेनैवार्थः प्रकाशेत ।** (*TSS* 101, p. 1).

7. *Siddhāntadarpaṇa-vyākhyā*, a commentary on his own *Siddhāntadarpaṇa*, edited here. The commentary is elaborate and resembles, in diction and treatment, his *Āryabhaṭīya-Bhāṣya*. It is in this work that Nīlakaṇṭha gives the actual date of his birth as Kali 4545 : A.D. 1443 (see below, pp. xxv-xxvi, 17).

8. *Grahaṇanirṇaya*, a work on the computation of lunar and solar eclipses. Manuscripts of this work are yet to be discovered, but later authors and Nīlakaṇṭha himself in his *ĀBh.Bhaṣya* quote from this work ; *cf.* **तदैव ग्रहणमध्यं च । स्फुटसाम्ये तु विक्षेपकोटिमण्डलापक्रममण्डलयोः भुक्तभागसाम्यमेव स्यात् ।** तदुक्तं मया ग्रहणनिर्णये —

परमक्षेपकोटिघ्नः पातोनार्कभुजागुणः ।
स्वेष्टविक्षेपकोट्याप्तस्तत्क्षेपकृतियोगतः ॥

पदं यच्चापितं यच्च पातोनार्कभुजाधनुः ।
तद्विशेषं हतं षष्ट्या गत्यन्तरहृतं क्षिपेत् ॥

पर्वान्ते युग्मपदे क्षेपे शोधयेद् विषमे पदे ।
एवंकृतोऽपि पर्वान्तः सूर्येन्द्वोर्ग्रहणे स्फुटम् ॥

(*TSS* 185, p. 102)

These verses are quoted also by Śaṅkara in his commentary on Nīlakaṇṭha's *Tantrasaṅgraha* (on ch. IV, verse 27, *TSS* 188, p. 107) with the introductory remark : तदुक्तमनेनैव ग्रहणनिर्णये ।

9. *Sundararāja-praśnottara.* Sundararāja, son of Ananta-nārāyaṇa, was an astronomer of the Tamil country contemporaneous with Nīlakaṇṭha and author of a detailed commentary on the *Vākyakaraṇa* or *Vākyapañcādhyāyī* which is a manual on the basis of which almanacs in the Tamil districts are computed.[1] Sundararāja had the greatest

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1. Cr. ed. by T.S. Kuppanna Sastri and K.V. Sarma, K. S. R. Inst., Madras, 1962.

respect for Nīlakaṇṭha whom he addressed for clarification of certain points in astronomy. Nīlakaṇṭha's detailed answers to these questions formed a regular work, *Sundararāja-praśnottara*. Manuscripts of this work are yet to come to light, but both authors refer to this work. Sundararāja in his commentary on the last verse of ch. V of the *Vākyakaraṇa* says[1] :

अत्र तु गतियोगांशकेनैव हरणं युक्तमिति श्रीमत्-केरलसद्ग्रामनिवासि-नीलकण्ठार्येण त्रिस्कन्धविद्यापारदृश्वना षड्दर्शनीपारंगतेन आश्वलायनसूत्रेण गर्गगोत्रेण नवकलरु(?)जातेन गोलचूडामणिना अस्मदनुग्रहार्थे सुन्दरराजप्रश्नोत्तराख्ये ग्रन्थे प्रतिपादितम् । तेन गतियोगेनैव विभज्य स्थितिदलं ज्ञेयम् ।

Nīlakaṇṭha too refers to this work in his *ĀBh.Bhāṣya*, *Gola.*, 48 : *cf.* सुन्दरराजप्रश्नोत्तराख्ये मयोक्तमत्राप्यनुसन्धेयम् (*TSS* 185, p. 149).

10. A *Gruhaṇādi-grantha*, copied in continuation of Nīlakaṇṭha's *Siddhānta-darpaṇa-vyākhyā* in the Trivandrum Palace manuscript No. 975. The work as available in this manuscript begins '**अथ ग्रहणम्**' and without any more introduction, continues : **नन्वेवमपि स्वकाल एव गीतिकोक्तभगणाद्या: । गीतस्य ग्रहणस्य [च] प्रत्यक्षसंवाद: स्यात् ।** It goes on to describe the necessity of correcting old astronomical constants by observation, deals in detail with the *Śakābda-saṁskāra*, quotes the verses of N's *Parama-guru* Parameśvara from his *Siddhāntadīpikā* (*Mahābhāskarīya-bhāṣya-vyākhyā*),[2] on the latter's observation of some eclipses and after some more discussion ends abruptly. There is no doubt that this work is from Nīlakaṇṭha's pen. References herein to his own works, teacher, etc. fully confirm this point. One of his own works is referred to herein thus : **अत एव मया छायागणिते तत्साधनतया दृक्क्षेपानयनमुक्तम्**—'**अन्त्यद्युज्या**' etc. (p. 60 of my transcript). The verses quoted are from Nīlakaṇṭha's *Candracchāyāgaṇita*, vv. 8-10. He refers to his grand-teacher Parameśvara and his own *ĀBh.Bhāṣya* too, herein : *cf.*, **तस्मात् सिद्धान्तदीपिकोदाहृतानि ग्रहणान्यस्माभिर्दृष्टानि च तत्तदवसरे वक्ष्यमाणानि परमेश्वरोक्तप्रकारेण अर्कादिमध्यममानीय श्रीपत्युक्तप्रकारेण स्फुटीकृत्य कालक्रिया-गोलपादोक्ताभिरस्माभिर्व्याख्याताभि: युक्तिभिस्सिद्धै: क्रियाविशेषैश्च गण्यन्ताम् ॥** (pp. 57-58 of my transcript). The *ĀBh.Bhāṣyā* also is referred to elsewhere in this work (*cf.* pp. 62, 63

1. *Ibid.*, p. 119.
2. Ed., *Madras Govt. Or. Ser.*, 130 (1957).

of the transcript). For a characteristic reference to N's teacher, see : प्रकारान्तरेण 'चन्द्रबाहुफलवर्गं' त्याविना श्रीमद्-दामोदराह्वयास्मद्गुरुमुखोद्गतेन श्लोकेनोक्ता, तद्युक्तिरपि आर्यभटीयान्तर्भूतैव ॥ (p. 61 of the transcript).

11. *Grahaparīkṣākrama* (?). The well-known Kerala astrologer Puliyūr Purushottaman Nampūtiri has edited[1] an old, incomplete[2] Malayalam summary of a Sanskrit work under the title *Grahaparīkṣākrama*. The textual verses were not available to the editor and he presumed that the author was Dṛggaṇita-Parameśvara.[3] These verse are, however, found in Nīlakaṇṭha's *Bhāṣya* on the *Golapāda* of the *Āryabhaṭīya*, under verse 48 (*TSS* 185, pp 132-49). It is a long tract of about 200 verse, summing up the principles and methods followed in Hindu astronomy and forms a veritable handbook on the subject. It ends :

इति संक्षेपतः प्रोक्ता परीक्षा ज्योतिषामिह ।
कालमानचतुष्कस्य श्रुतस्य विवृतिस्त्वियम् ॥

It is not however very definite whether this is an independent work with the title *Grahaparīkṣākrama* and is quoted in extenso in the *Bhāṣya* or is but a part of the *Bhāṣya*.

Nīlakaṇṭha should have written more works than those mentioned above since there are quotations attributed to him in later works, for instance, in Śaṅkara's commentary *Laghuvivṛti* on Nīlakaṇṭha's *Tantrasaṅgraha*, which could not be traced to his known works. Again, the Trivandrum Palace Ms. No. 975 containing Nīlakaṇṭha's *Siddhāntadarpaṇa-vyākhyā* and the work on eclipses etc. described above, has, in continuation, some incomplete tracts with no definite titles, which again, to all appearance, seem to be Nīlakaṇṭha's writings.

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1. Pub. by the Astrological Research Institute, Bombay-25, 1950.

2. The colophonic words at the end of the edition indicating its completion form only the editor's addition.

3. *Vide* the editor's Introduction, p. i ; see also Shri Nampūtiri's review and opinion on *Gaṇitaprakāśika* by K. V. A. Rama Poduval, Canannore, 1950, p. xiv.

According to some, Nīlakaṇṭha has composed a work entitled *Grahanirṇaya.*[1] It is likely, however, that this is only the *Grahaṇa-nirṇaya*, noticed above Ulloor attributes to Nīlakaṇṭha a work called *Gaṇitayukti.* Thus, speaking about a *Bhāṣāyuktibhāṣā*, he says that "it is not the work of Keḷallūr Comātiri, author of *Gaṇitayukti.*"[2] The ascription is wrong and the fact is that while our author belonged to the Gārgya-gotra, this latter work is by an anonymous author belonging to the Bhāradvāja-gotra as is clear from its first verse, which runs as follows :[3]

विदित्वार्यभटप्रोक्तगोलतत्त्वेन केनचित् ।
भारद्वाजेन तन्यन्ते काश्चित् गणितयुक्तय: ॥

Chronology of Nīlakaṇṭha's Works

It has been noticed[4] that Nīlakaṇṭha's *ĀBh.Bhāṣya* is later than his *Tantrasaṅgraha* and *Golasāra* which are quoted in the former. But nothing has been said about the chronology of his other works. The present writer's investigations have, however, shed some light on this matter.

The first five works enumerated above, *viz.*, *Golasāra*, *Siddhānta-darpaṇa*, *Candracchāyāgaṇita*, the commentary thereon, and *Tantra-saṅgraha* do not refer to any other work. but are, in their turn, quoted in other works of Nīlakaṇṭha. Of these, the *Tantrasaṅgraha* is the most comprehensive of the five and gives the date of its composition as 1500 A.D., *i.e.*, it was written when the author was fifty-seven. On the above considerations it may be presumed that the other four works were written before this date. The *Grahaṇanirṇaya* and the *Sundararāja-praśnottara*, of which manuscripts have yet to be discovered and which are quoted in the *ĀBh.Bhāṣya*, have also to be ascribed to about this period. This *Bhāṣya*,

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1. Vatakkumkur, *Hist. of Skt. Lit. in Kerala*, vol. I, p. 389 ; Ulloor, *Kerala Sāhitya Caritram*, vol. II, p. 117.

2. Uloor, *Ibid.*, p. 122.

3. Ms. : Madras, Mal. D. 339, pp. 83-89, now, transferred to the Kerala Univ. Or. Res. Inst. and Mss. Library, Trivandrum.

4. Ulloor, *Kerala Sahitya Caritram*, vol. II, p. 119.

a mature work, Nīlakaṇṭha wrote when he was very old, as he himself remarks : मयाद्य प्रवयसा ··· यथाकथंचिदेव व्याख्यानमारब्धम् (*TSS* 101, p. 156). The *Siddhānta-darpaṇa-vyākhya* which refers to the *Āryabhaṭīya-Bhāṣya*, (*Cf.* com. on verse 25 : एतत् सर्वं मया आर्यभटीयव्याख्याने प्रपञ्चितमिति विरम्यते । see p. 24, below) is still later. And so also his discursive treatise on eclipses which too refers to the *ĀBh.Bhāṣya* more than once ; *cf.* तत्र कालक्रियापादे सूचितं मया विवृतम् (p. 63 of my transcript) ; एतत् सर्वं गणितपादे विस्तरेणोपपादितं । (*ibid*, 63).

Date of Nīlakaṇṭha

Indisputable evidences are available for fixing the date of our author. Śaṅkara, Nīlakaṇṭha's pupil, in his commentary on his teacher's *Tantrasaṅgraha*, points out that the first and last verses of that work contain chronograms specifying the dates of the commencement and of the completion of the work. Thus, after giving the literal meaning of the first verse of the work :

'हे विष्णो निहितं कृत्स्नं' जगत् त्वय्येव कारणे ।
ज्योतिषां ज्योतिषे तस्मै नमो नारायणाय ते ॥

Śaṅkara says : आचार्येण इमं श्लोकं आदितो ब्रुवता प्रथमपादेन प्रबन्धारम्भदिन-कल्यहर्गणश्च अक्षरसंख्यया उपदिष्टः । समाप्तिसमयाहर्गणश्च 'लक्ष्मीशनिहितध्यान' इत्यन्ते भविष्यति ।

These two Kali dates, 16,80,548, and 16,80,553, work out to Kali Year 4601, Mīna 26, and 4602, Meṣa 1, both dates occurring in April 1500.

The *Siddhānta-darpaṇa* and Nīlakaṇṭha's own commentary thereon give, respectively, the year and actual date of his birth. *Cf.* :

Text : कलिसन्ध्याष्टमांशे स्वशतांशाढ्ये गते ततः ।
धनुर्मिथुनयोर्मध्ये प्रायशस्त्वयने उभे ॥
(*Sid. dar.* 18)

Com. : द्वियाब्दशतमिता खलु काले सन्ध्या स्मर्यते । तस्य अष्टमांशः सार्धद्विव्याब्दद्वादशकः । स च सौराब्दानां पञ्चचत्वारिंशत् शतमितः (4500) । तस्य शतांशः पञ्चचत्वारिंशदब्दः (45) । ततः स्वशतांशाढ्यः 'शिवशिवे'ति (4545) कल्यब्दैस्तावति याते उभे अयने उत्तरदक्षिणाख्ये प्रायशो धनुर्मिथुनमध्ये स्तः । तदा

अयनचलनांशाः धनात्मकाः पञ्चदशसंख्या बभूवुः । प्राथिकत्वं च कलाष्टकाधिकत्वात् । यतो भार्गव-परमेश्वराचार्येण अस्मत्परमगुरुणा 'चन्द्रांशास्त्वं' (4536) इति कल्यब्दे परीक्ष्य पञ्चदशांशपूर्तिर्निर्णीता । अतः सन्ध्याष्टमांशशतांशस्य प्राथिकत्वम् । स्वजन्मकालज्ञापनार्थं चैवमुक्तम् । तदा अहर्गणश्च 'त्यजाम्यज्ञतां तर्कैः (16,60,181) **इति ।** (p. 17, below). Here, Nīlakaṇṭha himself says that he was born on the Kali day 16,60,181, which works out to A.D. 1443 Dec. (Kali 4545 Vṛścika).

That Nīlakaṇṭha lived to a ripe old age, even to become a centenarian, is attested by a contemporary reference made of him in a Malayalam work on astrology, *viz.*, the *Praśnasāra* by Mādhava, a Nampūtiri brāhman of the Īñcakkāzhvā house in Kerala, who wrote his work in A.D. 1542-43. Here, Mādhava says that he could count upon reputed authorities like 'Keḷanallūr' to recommend his work. *Cf.* :

> āḷ-āyat-ādaravil ādiyil Attimaṯṯam
> lōkōttaran punar-itinn-iha '*Kēḷanallūr*' /
> ābhāsar allarivatuḷḷavar ādarippān
> porum prasiddhi perikoḷḷavar uṇṭanekam //

The date of composition of this work, *Praśnasāra*, is given as Kali 4644 (A.D. 1542-43) by the following verse in the work itself :

> ezhunūṯṯorupatteṭṭāvatu Kollam atāya nāḷ /
> varunna viṣuvad *bhāvatattvam* (4644) kalyabdam āyatu //

Rightly does Nīlakaṇṭha remark in his *Ā.Bhāṣya* **मयाद्य प्रवयसा ··· ··· यथाकथंचिदेव व्याख्यानमारब्धम्** (*TSS* 101, p. 156). Moreover, we know of at least two more works composed by him subsequent to his writing the *ĀBh.Bhāsya*, *viz.*, the commentary on the *Siddhānta-darpaṇa* and the work on eclipses etc., both of which quote the *ĀBh.Bhāṣya*.

Versatility of Nīlakaṇṭha

For a mere Jyautiṣika and one who had specialised only on its astronomical aspect, Nīlakaṇṭha seems to be very well read. Every other page of his writings substantiate his knowledge of the several branches of Indian philosophy and culture. Sundararāja, the Tamil astronomer, calls him *ṣaḍ-darśanī-pāraṅgata*, 'one who had mastered the six systems of philosophy'.[1] Nīlakaṇṭha himself informs us that he

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1 *Cf.* his commentary on the *Vākyakaraṇa*,, 5.19 (edn., p. 119).

studied Vedānta under Ravi : *cf., Ravita atta-Vedāntaśāstreṇa.* He can refer to a Mīmāṁsā authority to establish a mathematical point[1] and with equal felicity apply a grammatical dictum to the same purpose.[2] Piṅgala's *Chandas-sūtra*[3] and the lexicons are quoted as the occasion demanded. The scriptures and the Dharmaśāstras also come in for citation.[4] And, so also the Purāṇas[5] like the *Bhāgavata*[6] and the *Viṣṇu.*[7] As for Jyotiṣa works, Nīlakaṇṭha exhibits a surprising familiarity with a large number of them, from the *Vedāṅga-Jyotiṣa* down to the treatises of his own times. He uses all types of jyotiṣa texts, *Gaṇita, Saṁhitā* and *Horā,* but as became his subject of specialisation, his quotations are mainly from texts dealing with astronomy proper. Some of the more important texts of all-India prevalence that Nīlakaṇṭha quotes are : *Vedāṅga-Jyotiṣa, Āryabhaṭīya,* Varāhamihira's *Pañcasiddhāntikā, Bṛhajjātaka* and *Bṛhatsaṁhitā,* the *Sūryasiddhānta,* Śrīpati's *Siddhāntaśekhara* and Muñjāla's *Laghumānasa.* Of texts popular mainly in Kerala may be mentioned the *Parahitagaṇita* or *Grahacāranibandhana* of Haridatta, the *Bhāṣya* by Bhāskara I on the *Āryabhaṭiya* and his *Laghu* and *Mahābhāskarīyas,* Govindasvāmin's *Bhāṣya* on the latter and Parameśvara's super-commentary thereon ; other works of Parameśvara like his *Āryabhaṭīya-vyākhyā* also come in for citation as also passages from his own teacher Dāmodara. Another Kerala author whom Nīlakaṇṭha quotes often is Mādhava, often styled 'Golavid', who

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1. *Cf. ĀBh.Bhāṣya, TSS* 101, pp. 54, 158, where Pārthasārathi Miśra's *Vyāptinirṇaya* and *Advaitavivaraṇa* and *Ajitā* (com. on *Ślokavārttika*) and its commentary *Vijayā* come in for quotation. On *Golapāda,* 50, the *Bṛhaṭṭīkā* of Kumārila Bhaṭṭa is cited.

2. *Cf.* quotations from the *Vākyapadīya, ĀBh. Bhāṣya, TSS* 110, p. 31.

3. See *ĀBh.Bhāṣya, TSS* 101, p. 4.

4. See com. on *Siddhānta-darpaṇa,* verses 1, 2; the Grahaṇa work pp. 48, 49 ; and *Āryabhaṭīya-bhāṣya, Golapāda,* verse 48, where the *Taittirīya-Āraṇyaka, Ṛgveda, Pārāśarasmṛti, Kālanirṇaya* of Sāyaṇa, *Manusmṛti* etc. are quoted.

5. See *Siddhānta-darpaṇa-vyākhyā,* p. 1.

6. *Cf., ĀBh.Bhāṣya, TSS* 110, pp. 16, 26.

7. *Cf., ibid.,* p. 8.

was a reputed astronomer of the times.[1] Manuscripts of several works quoted by Nīlakaṇṭha are yet to be unearthed and a detailed study of the numerous authorities quoted by Nīlakaṇṭha is bound to throw welcome light on the annals of Hindu astronomy.

Acknowledgements

As mentioned earlier, the textual verses of the *Siddhānta-darpaṇa* had been edited by me with Translation through the pages of the *Adyar Library Bulletin* in 1955. The authorities of the Adyar Library and Research Centre graciously agreed to my using the said edition in the present publication with Commentary. I am extremely grateful to them for this kind gesture. From out of the ten manuscripts made use of in this edition, nine, being five manuscripts of the text, one of the Text with Commentary, and three of the Appendices, belong to the Oriental Research Institute and Mss. Library of the Kerala University, Trivandrum. My thanks are due in full measure to the authorities of this institution for making these manuscripts available for my study. My thanks are due in equal measure also to the India Office Library, London, from whom the tenth manuscript was procured. To Prof. T.S. Kuppanna Sastry, formerly of the Presidency College, Madras, I am indebted for the interest he took in the work and the help and advice he gave towards its edition and translation. True to form, the V.V.R.I. Press have done their work with painstaking care. Full credit is due to them in this regard.

K.V. SARMA

Vishveshvaranand Institute,
Panjab University, Hoshiarpur,
'Independence Day',
August 15, 1976

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1. On this Mādhava, (*c.* 1340-1425), who was a teacher of Parameśvara, see the present writer's Introduction to his edition of Mādhava's *Veṇvāroha*, (Trippunithura, Cochin, 1957), and *Sphuṭacandrāpti*, (Hoshiarpur, 1973).

नीलकण्ठ-सोमयाजि-विरचितम्

सिद्धान्तदर्पणम्

ग्रन्थकर्तृप्रणीतया व्याख्यया समेतम्

[मङ्गलाचरणम्]

[1]श्रीमद्दामोदरं नत्वा भगवन्तं रविं तथा ।
तत्प्रसादान्मया लब्धं ज्योतिश्चरितमुच्यते ॥ १ ॥

[व्याख्या]

·········य]स्माद्[1] ब्राह्मणेन निष्कारणो धर्मः षडङ्गो वेदोऽध्येयः, तदर्थश्च ज्ञातव्यः' (तैत्तिरीय-आरण्यकम्, २.१५), इति, तस्माद् ब्राह्मणेन विहिताननुष्ठाननिमित्तात् प्रत्यवायाद् बिभ्यता अवश्यमध्येयानि[2] शिक्षादि-षडङ्गानि इति सिद्धम् ॥१॥

मूलम्— 1. Mss. used : **A** (Ms. No. 475-D), **B** (No. 5867-C), **C** (No. C. 1869-C), **D** (No. C. 1024-F), **E** (No. 8358-I), (all from the Kerala Univ. Or. Res. Inst. and Mss. Library, Trivandrum, **F** (No. 6302) from the India Office, London and **G** (No. 975) from Trivandrum Palace Collection.

व्याख्या—1. The only available manuscript of the work (Trivandrum Palace Collection, Ms. No. 975), commences from here, the first folio containing the beginning of the commentary having been lost.

2. Ms. reads ध्येयानीति

१. उपदेशभागः

[ग्रहपर्ययाः]

[1]'कोटिघ्न-रदवेदाः'[2] प्राक् कल्पे सूर्यस्य पर्ययाः[3] ।
'भूदन्तरददेवेषु[4]'सप्ताद्यूर्था' विधोः, क्षितेः ॥ २ ॥

अथ चतुर्भिः श्लोकैः सूर्यादीनां कल्पपर्ययाः प्रदर्श्यन्ते—

432,00,00,000
कोटिघ्न-रदवेदाः प्राक् कल्पे सूर्यस्य पर्यय[ा]ः ॥ २a ॥

इति । ये प्राग्गत्या सूर्यादीनां स्वस्ववृत्तपर्यय[ा]ः ते **कल्पे** एतावन्तः स्युः इत्यर्थः । तत्र **कोटिघ्ना रदवेदाः सूर्यस्य पर्यया** भगणाः । अश्विन्यादिपौष्णान्तो भगणः । ननु मेषादिमीनान्तो भगण इति कुतो न व्याख्यायते ?

तेषां तु [परिवर्तन][1] पौष्णान्ते भगणः स्मृतः ।

इति **सूर्यसिद्धान्तोक्तेः** (२. २७), इह 'भ'शब्दस्य नक्षत्रवाचकत्वात् । राशिवाचकत्वे हि मेषादिमीनान्तत्वं स्यात् । यद्यपि—

पुनर्द्वादशधात्मानं विभेजे राशिसंज्ञितम् ॥
नक्षत्ररूपिणं भूयः सप्तविंशात्मकं वशी ।
(सूर्यसि० १२. २४-२५)

इत्युभयेषां कालपुरुषावयवत्वमविशिष्टम्, तथापि समूहवाचिना गणशब्देनाभिधानं नक्षत्रगणस्यैव [यु]क्तम्, अधिकसंख्यात्वात्; न राशिगणस्य अन्यस्मादल्पसंख्यत्वादिति भावः । अथवा राशिभ्यो नक्षत्राणां प्रसिद्धतर[त्वाद्] ग्रहणं युक्तम् । प्रसिद्धतरत्वं च तेषां [क]ल्याणाकल्याणभेदात्, तज्ज्ञानस्य कर्मसूपयोगभूयस्त्वाद् इत्याशयः ।

मूलम्— 1. G. available only from here.
2. वेदार्काः (wr.)
3. G. पर्ययः; so also in the comments, below.
4. B. F. G. वेदेषु (wr.) ; G. however, gives the number correctly as 533 in the commentary.

व्याख्या—1. G. reads परिध्यूने for परिवर्तन

रविभगणाः कोटिघ्न-रदवेदा एव, न न्यूनाधिकाः । न हि रविभगणनाम् आचार्यैः नानावचनं युक्तम् ।

चत्वारि त्रीणि द्वे चैकं कृतादिषु यथाक्रमम् ।
दिव्याब्दानां सहस्राणि युगेष्वाहुः पुराविदः ॥

तत्प्रमाणैः शतैः सन्ध्या पूर्वा तत्राभिधीयते ।
सन्ध्यांशकश्च तत्तुल्यो युगस्यानन्तरं हि सः ॥

सहस्रयुगपर्यन्तमहर्यद् ब्रह्मणो विदुः ।
रात्री युगसहस्राणां तेऽहोरात्रविदो जनाः ॥

इत्यादिभिः पुराणेतिहासस्मृतिषु व्यवस्थापितत्वाद् युगाब्दानाम् । रविभगणस्यैव हि देवासुराहोरात्रत्वम् ।

देवासुराणामन्योन्यमहोरात्रं विपर्ययात् ।
(सूर्यसि० १.१४ ; १४.२०)

इति द्युनिशोर्व्यत्यासे सत्यपि नाहोरात्रपरिमाणभेदः । उत्तरायणमध्ये विषुवत्संज्ञे काले देवानामुदयः । तदेवासुराणामस्तमयश्च । दक्षिणायनमध्ये विषुवति देवानामस्तमयोऽसुराणामुदयश्चेति भेदः ।

ननु उत्तरायणं कृत्स्नं देवानामहः, दक्षिणायनं रात्रिश्च—

शिशिरपूर्वमृतुत्रयमुत्तरं ह्ययनमाहुरहश्च तदापरम् ।
भवति दक्षिणमन्यदृतुत्रयं निगदितो रजनी मरुतां च सा ॥

इत्यादिस्मृतेः । नैष दोषः । तत्राप्युन्नतकालो दिनत्वेन व्यवस्थितः, रात्रिकालश्च रात्रितया ।

आ मध्याह्नादार्धरात्राद् दिवा रात्रिरिति क्रमात् ।

इति पाराशरे दृश्यकालो दिनत्वेन विवक्षितः, अदृश्यकालो रात्रिश्च । यतोऽर्धरात्रे रवेर्दिनबलं शून्यम्, ततः क्रमेण वर्धमानं मध्याह्ने परिपूर्णं स्यात् । ततः क्रमेण हीयमानं अर्धरात्रे शून्यतां याति, इति बलनिरूपणावस्थायामेव आरोहणकालस्य दिवाख्या, अवरोहणकालस्य रात्र्याख्या च । उत्तरायणं च देवानामुन्नतिकालः; दक्षिणायने रवेरवनतिश्च, मेरुसंस्थत्वात् तेषाम् ।

उद्यन्नद्य मित्रमह आरोहन्नुत्तरां दिवम् ।
हृद्रोगं मम सूर्यः हरिमाणं च नाशय ।

उदगादयमादित्यो विश्वेन सहसा सह ।
द्विषन्तं मह्यं रन्धयन् मो अहं द्विषते रधम् ॥
(ऋग्वेदः, १.५०.११, १३)

इत्यादि मन्त्रवर्णतश्च आरोहतः सूर्यस्य इष्टफलप्रदत्वं बलवृद्धिश्चावगम्यते । अतो युज्यत एव देवभागस्थान् प्रति उत्तरायणे अभीष्टफलप्रदत्वं रवेः । दक्षिणायने चासुरभागोद्‌गमनात् तदपेक्षया बलवृद्धेः तदिष्टफलप्रदत्वाद् अनिष्टफलप्रदत्वं च नो युज्यते, 'द्विषन्तोऽन्योन्यमाश्रिताः' इत्युक्तेः । तस्मात् 'उत्तरायणे कृतमुपनयनादिकं इष्टप्राप्तये, दक्षिणायने अनिष्टप्राप्तये च स्यात्'। इत्युदगयनादिविधेः प्रशंसार्थमेव उत्तरायणस्य दिवाऽख्यत्ववचनमित्यविरोधः । 'विषुवतोरुदयास्तमयेन देवासुराणाम्' इति यदुक्तं तद् युक्तमेव ।

सुरासुराणामन्योन्यमहोरात्रं विपर्ययात् ।
(सूर्यसि० १.१४; १४.२२)

इति चोपपद्यते । एवं रविभगणस्य दिव्याहोरात्रत्वाद् रविभगणानां षष्ट्युत्तरशतत्रयमेव दिव्यं वर्षम् । उक्तं च—

षष्टिसङ्गुणं (? गुणितं) दिव्यं वर्षमासुरमेव च ।
तद्द्वादशसहस्राणि चतुर्युगमुदाहृतम् ॥

सूर्याब्दसंख्यया द्वित्रिसागरैरयुताहतैः ।
सन्ध्यासन्ध्यांशसहितं विज्ञेयं तच्चतुर्युगम् ॥

इति युगरविभगणानां व्यवस्थितत्वात् केनचिदपि नावापोद्वापौ कार्यौ । अतः कल्पभगणा अपि कोटिघ्नरदवेदा एव सर्वैर्वाच्याः, युगसहस्रात्मकत्वात् कल्पाख्यस्य ब्रह्मदिवस्य ।

य[तश्चा]ब्दा भटस्यापि द्वित्रिवेदहतायुताः ।
युगानां तन्मते कल्पे त्वष्टोत्तरसह[स्रकाः] ।
435,456
कल्पार्काब्दास्ततोऽस्या'ङ्गेष्वब्धिभूताग्निसागराः' ।
कृतादीनां चतुर्णां स्यात् तुल्यत्वाद् युगपादता ॥
432,00,00,000
'अह्नीनेन ननानेद्रे गावः' कल्पेऽर्कपर्ययाः ॥

'खखेषुगोगुणाष्टाश्वाग्न्यशिवद्व्यष्टशरेन्दवः' ।
'सप्ताग्न्येकाशिवषण्णागरसाङ्काकृतयो'ऽसृजः ॥ ३ ॥

[1]स्वबृत्तेऽ'र्थाश्वभूखार्काद्रिद्व्यग्न्यङ्कात्यष्टयो' विदुः ।
गुरो'रीशाङ्कखाङ्गैकवेदाङ्ग'[2]शिखिनः', कवेः ॥ ४ ॥

[3]'द्वीष्वर्थाभ्रभनेत्राग्निखागा'[4], लङ्कोदयाच्छनेः ।
'नृपाशाश्वेषु तर्केन्द्रा', भुवोऽन्ये वारपा ग्रहाः ॥ ५ ॥

57,75,33,32,321
भूदन्तरददेवेषुसप्ताद्यूर्था विधोः, क्षितेः ॥ 2b ॥
57,75,33,32,321
'यत्राम्बुखण्डबिम्बे मृतसच्छांशो' शशिनस्तथा ॥

15,82,23,78,39,500
खखेषुगोगुणाष्टाश्वाग्न्यशिवद्व्यष्टशरेन्दवः ॥ ३a ॥

इति ।

क्षितेः कल्पे प्राग्भ्रमणसंख्या भानां क्षित्यपेक्षया प्रत्यग्भ्रमणसंख्याः । उभयथापि ग्रहकर्मणि न विशेष इत्यभिप्रायः । अतएव 'भोदया' [इति] उच्यन्ते । यतो भूभ्रमाद् यावन्तः कल्पे तावत्कृत्वो भान्युद्यन्ति । भोदयेभ्यस्तत्तद्भगणानपास्य ग्रहाणामुदयश्च ज्ञेयाः । उक्तं च—

भोदया भगणैः स्वैः स्वैरूना स्वस्वोदया युगे ।

(सूर्यसि० १.३३)

इति ।

मूलम्— 1. A. B. read this line as : ज्ञस्यार्काश्विखाब्ध्यगाभ्राद्रित्र्यङ्काद्येका स्वमण्डले । which also gives the figure given in verse 1 of Appendix I, below. The reading adopted in the edition is the one given in the author's commentary.

2. F. वेदाग (wr.)

3. G. gives a corrupt but variant reading : चकरर्थाकखभाश्वक्षि ।

4. F. खांगा (corrupt)

कुतः पुनर्भोदयाः स्वभगणोनाः स्वोदयाः स्युः ? भचक्रभ्रमण-विपरीतदिक्त्वात् ग्रहभ्रमणस्य । भचक्रं हि प्रत्यग् भ्रमति । ग्रहास्तु तत्र भचक्रे प्राङ्मुखा भ्रमन्ति । अतो युज्यत एव भानां प्रत्यग्भ्रमणसंख्यातो ग्रहस्य प्राग्भ्रमणसंख्यान्यूनत्वं स्वस्य प्रत्यग्भ्रमणानाम् । तस्माद् रविभगणोना आर्क्षदिवसा सावनाः स्युः । यतो भानोः प्रत्यग्भ्रमः सावनो दिवसः, [स] एव भूदिवसश्च । यथोक्तम्—

उदयादुदयं भा[नोः] भूमिसावनवासराः ।

(सूर्यसि० १.३६)

इति । तस्मादिहोक्ता भूपर्यया एव आर्क्षदिवससंख्या । स हि रविभगणोनो सावनसंख्या ।

15,82,23,78,39,500

'अनुमाधोगहंसागुप्रग्रहे मध्य' आर्क्षजा ।

15,77,91,78,39,500

'स्नाने शुद्धिर्गृहस्थस्य धीस्था सा मर्त्य'सावनाः ॥

कल्पार्कभगणानिन्दोर्भगणेभ्यो विशोध्य तु ।
ज्ञेयाश्चन्द्रमसो मासा,स्त्यक्त्वा सौरांस्ततोऽधिकाः ॥

भवेयुर्दिवसा, मासाः सर्वेषां त्रिंशता हताः ।
सावनाहानि चान्द्रेभ्यो द्युभ्यः प्रोह्य तिथिक्षयाः ॥

इतिहासपुराणेभ्यो लोकाच्चातीतवत्सराः ।
वक्ष्यत्यत्रापि यातानि युगान्यब्दांश्च तद्गतान् ।

"युगं कल्पसहस्रांशो मनुस्तान्येकसप्ततिः ।
सन्धयः कृततुल्यास्तदाद्यन्ताभ्यन्तरेष्वपि ॥

युगस्यापि दशांशोऽब्धित्रिद्व्येकघ्नः कृतादि च ।
अष्टाविंशे युगे तिष्यः सप्तमस्य मनोरयम् ॥"

(सि० दर्पणम्, ११-१२)

इत्यतो वर्तमानात् प्राक् कलेः काल इहोदितः ।
कलेर्यातं गुरोर्ज्ञात्वा फाल्गुनान्ते मुहुः स्वयम् ॥

अत्र तावत् क्षिपेदेकं सौराब्दांस्ताननुस्मरेत् ।
द्वापरान्तं प्रसंख्याय संख्यामेकत्र पिण्डयेत् ॥
चतुर्युगदशांशान् वा द्वापरान्तगतान् न्यसेत् ।
6
मन्वन्तरयुगान्येकसप्तति गुणयेद् रसैः ॥

सप्तमस्य मनोर्याता युगानां सप्तविंशतिम् ।
10
क्षिप्त्वा च गुणयेद् दिग्भिः, सप्तसन्धिकृतैर्युतान् ।
अष्टाविंशयुगे यातान् दशांशान् नव योजयेत् ।
426
यद्वोत्कृतिकृतैस्तुल्ये षण्मनूनां चतुर्युगे ।
10
क्षिप्त्वाष्टाविंशतिं दिग्भिर्हत्वा रूपं विशोध्य च ।
4
कृतघ्नसप्तसन्धीनां क्षेपोऽष्टाविंशतेरिह ॥

4567
'सितः शिवा' इतीष्टाऽत्र कल्पादिध्रुवसाधने ।
प्रमाणमयुतं कल्पे चतुर्युगदशांशकाः ।
4567 10,000
हत्वा 'सितशिवै.' काल्पं 'नानाज्ञानकु'बुद्धृतम् ।
द्वापरान्ताधिमासादि ग्रहपातोच्चमध्यमम् ॥

द्युगणेऽप्येवमानीते योजयेत् कल्पहर्गणम् ।
432,000
यद्वा युगदशांशाब्दो सहस्रघ्नरदाब्धिभिः ।
4567
क्षुण्णे 'सितशिवे' युक्त्वा कल्यब्दद्युगणे नयेत् ।
197,29,44,000
नाकत्रयाब्धिकृताङ्काश्विसप्तातिधृतयः[1] कृताः ॥

सौराब्दा द्वापरान्तेऽत्र व्यासादिमुनिसम्मताः ।
पृथक् कल्पादिमासघ्ना हृता कल्पाधिमासकैः ॥

व्याख्या—1. The ms. reads धृतयोः

15,93,33,32,321
'पष्ठेद् गुरोर्बली बोद्धुं शिष्यः,' कल्पाधिमासकाः ।
51,84,00,00,000
'आनूनज्ञानिनं नत्वा दर्पणे' मास उष्णगोः ॥

लब्धाधिमासकान् युक्त्वा प्रथमस्थेषु दिनीकृताः ।
मासयातदिनैर्युक्ताः पृथक् कल्पावमाहृताः ॥

कल्पचान्द्रदिनैर्भक्ताः शोध्या स्युरवमागताः ।
प्रथमर्क्षात् सावनः शेषो द्युगणोऽर्कोदयावधि ॥

सप्तभिः क्षुभितः, शेषः सूर्याद्यो वासरेश्वरः ।
160,29,99,69,630
'उद्गता धीस्तु धद्धा धीरा इति कि'मु[ता]क्षरैः ॥

तिथयः, कल्पजे याभ्यः सावने शोधितेऽबलाः ।
53,43,33,32,321
'यत्र गात्रबलं बाले स्वो गुणे'श्चान्द्रमासकाः ॥

25,08,21,30,130
'[उ]ल्लेखयानां लयं राजन्नमरा' दर्पणावमाः ।
63,12,61,50,712
'श्रेयसे नौमिका चन्द्रकलान्तो' द्वापरान्तजः ॥

7,20,63,50,77,300
'ज्ञानगाथार्थिनां शूली तनुरच्छा'गतं दिनम् ।
शोध्या मध्यमसंक्रान्तावेकविंशतिनाडिका ॥

रात्रौ नाड्यां नवम्यां तं रविपर्ययपूरणम् ।
पूर्णे वा द्युगणे प्रोक्ते शुक्रवाराद्यहर्गणः ॥

क्षिप्त्वा कलिगतं ज्ञेयः कल्पयातोऽर्कवारतः ।
उदयावधिकोऽत्रेष्ठा ग्रहपातादिमध्यमे ।
फलं स्वभगणास्तेषां प्रमाणं कल्पभूदिनम् ॥

2,29,68,62,137
'सप्ताग्न्येकाग्निवषण्णागरसाङ्काकृतयो'ऽसृजः ॥ ३८ ॥

2,29,68,62,137

'सालोक्या: श्रितवीप्तोद्धा वक्रा' कल्पे कुजस्य च ॥

17,93,71,20,175

स्ववृत्ते'ऽर्थाश्विभूखार्काद्रिधगन्यङ्कात्यष्टयो' विदु: ॥ ४a ॥

17,93,71,20,175

'मासपक्षा रयो स्थूलधीसाध्या' बुधपर्ययाः ॥

स्ववृत्ते इत्यनेनान्येषामिव बुधशुक्रयोरपि स्वबिम्बगत्या स्ववृत्तपरिपूरणसंख्या एवात्र निर्दिष्टा भगणा:, न तु तयो: शीघ्रोच्चस्य ।

ताराग्रहाणां सर्वेषां शीघ्रोच्चं रविरेव हि ।

गोलयुक्त्योपरिष्टात्तत् स्फुटे स्पष्टीभविष्यति ॥

36,41,60,611

गुरो'रीशाङ्कखाङ्कैकवेदाङ्कशिखिन:', कवे: ॥ ४b ॥

36,41,60,611

'कल्पान्तोनोच्चपर्वाग्निफलीना' जीवस्य पर्ययाः ॥

7,02,22,70,552

[1][द्विशरार्था]खभाश्व्यक्षिखागा लङ्कोदयात्, शने: ॥ ५a ॥

7,02,22,70,552

'प्रमाणज्ञ: सुरश्रेष्ठनाथा:' कल्पाच्छपर्ययाः ॥

[ल]**ङ्कोदया**दिति सर्वत्र संबध्यते । लङ्कायां मीनमेषसन्ध्युदये तत एव सूर्यादीनां स्वस्व[क]क्ष्यासु भ्रमण[प्र]वृत्ति: । चन्द्रादिपातानां मीनान्तात् प्रभृति प्रतिलोमभ्रम[ण]प्रवृत्तिश्च । द्वितीयपातानां कन्यान्ताच्च ।

14,65,71,016

'नृपाशाश्वेषु तर्केन्द्रा', भुवोऽन्ये वारपा ग्रहाः ॥ ५b ॥

14,65,71,016

'तपनाद्या: समन्ताद् भे व्योम्नि' मन्दस्य पर्ययाः ॥

भुवोऽन्ये वारपा ग्रहा:[2] तेष्वप्यनयो: मध्यगतेषु मध्ये भुवं क्षितिं विना येऽन्ये सप्त ते ग्रहा: क्रमेण वाराधिपा: स्यु: ।

व्याख्या—1. The ms. reads चकरर्थाक for द्विशरार्था

2. Ms. Hapl. repetition of तपनार्क्यो: (?द्या:) सम here.

ननु रवेः इतरेभ्यः प्राधान्यात् (? प्राथम्यम्)। चन्द्रस्य द्वितीय[त्व]-मप्यस्तु। कुतः पुनः कुजस्य तृतीयत्वम्? सर्वेभ्योऽल्पत्वाच्चरमत्वमेव युज्यते। भृगु-गुरु-बुध-शनि-भौमानामेव क्रमेण तृतीयादित्वमुपपद्यते।

नवभिर्भूगोस्तंद्व्यधिकैर्द्व्यधिकैर्यथा श्लक्ष्णा.।

(आर्यभटीयम्, गोल० ४)

इत्युक्तेः। निसर्गबलक्रमश्च [स][1] एव। तस्माद् वारपत्वक्रमेणापि तेनैव भवितव्यम्। नैतदस्ति। काल-होरा-दिनाद्याधिपत्यं कक्ष्यात्मानुसार्येव[2] स्मर्यते—

भानामधः शनैश्चर-सुरगुरु-भौम-र्क-शुक्र-बुध-चन्द्राः।

तेषामधश्च भूमिर्मेधीभूता खमध्यस्था॥

सप्तैते होरेशाः शनैश्चराद्या यथाक्रमं शीघ्राः।

शीघ्रक्रमाच्चतुर्था भवन्ति सूर्योदयाद् दिनपाः॥

(आर्यभटीयम्, काल० १५-१६)

इति। दिनाधिपत्यस्य किल होराक्रमेण चतुर्थत्वमपि तत्तद्दिनाद्यकालहोरेशस्य वारेशत्वादेव स्यात्। यतः अहोरात्रकाले कालहोराश्चतुर्विंशतिः सन्ति। [ताभ्यः][3] एकविंशत्यैव त्रिः परिवृत्तौ। शिष्टानां तिसृणां चतुर्थावृत्तिगतानां पूर्वास्विव तदहोरात्राद्यकालहोरेशात्प्रभृति शीघ्रक्रमेण त्रयाणां ग्रहाणां परेद्युरुदयात्प्रागेवातीताः [होराः]स्युः। या पुनश्चतुर्थी परेद्युराद्या कालहोरा तदीशः पूर्वेद्युराद्यकालहोरेशात्प्रभृति कक्ष्याक्रमश्चतुर्थं इति क्रमप्राप्तमेव परेद्युः पूर्ववारेशात्प्रभृति कक्ष्याक्रमेण चतुर्थस्य वाराधिपत्यम्। अत एव सूर्यानन्तरं चन्द्रस्य, न पुनस्ताराग्रहेभ्यः, प्रकृष्टप्रकाशत्वात्। चातुर्थ्यं च शीघ्रक्रमापेक्षया। अर्काच्चन्द्रस्य यतोऽर्कगतेर्महती शुक्रगतिः स्यात्, ततोऽपि महती बुधस्य, ततोऽपि चन्द्रस्य, इत्यर्कशुक्रबुधचन्द्राणां क्रमाच्छीघ्रगतित्वात् क्रमेण अर्काच्चतुर्थश्चन्द्रमाः। एवं कालहोराक्रमत्वम्। वारेशानां कालहोराक्रमश्च कक्ष्याक्रमवशादित्यवगन्तव्यम् इत्यभिप्रायात्(? प्रायः)।

द्वि नव द्वादशांशो मता कालहोरा पतिस्तस्य पूर्वस्य वाराधिनाथः।

ततः षष्ठषष्ठा क्रमेणेतरेषां निशायां तु वारेश्वरात् पञ्चमाद्याः॥

इति यदुक्तं तत्र निमित्तनिमित्तिनोर्व्यत्यासः स्यात्।

व्याख्या—1. Ms. reads ता for स

2. Ms. reads : कक्ष्यात्मा एवानुसारेव

3. Ms. reads ता स्युः for ताभ्यः

[मन्दोच्चपर्ययाः पातपर्ययाश्च]

तेषां 'त्रीष्वग्नयोऽष्टैक[1]सुरार्काष्टाहिसागराः' ।
मन्दोच्चानां 'कृतेष्वश्वा' 'वेदतानाः' 'कुखर्वतः' ॥ ६ ॥

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[1]एकस्तत्र कला ··· ··· ··· होराक्रमे वा । क्रमो निमित्तत्वेनोक्तः । वस्तुतस्तु वारक्रमे कालहोराक्रमस्यैव निमित्तत्वम् इति तान्मात्रश्रव[णे][2] गम्यगमकयोर्व्यत्यासः प्रतीये[त] । तस्मात् शास्त्राभ्यासा[भ्य]सितसंस्कार-वाण्यनुसारिणी तदुक्तिः । निशायां तु वारेश्वरपञ्चमाद्यत्वमपि कक्ष्याक्रम-प्राप्तमेव । यतोऽर्कवारे द्वितीया[वृत्तौ गते][3] अर्कशुक्रबुधचन्द्रशनीनां जीवैव (?) गता । ततो षष्ठी निशायामाद्या । तस्मात् कक्ष्याक्रमेणैव होरेशा गण्याः । तथा च लाघवं स्यात् । मासाधिपत्यं च सावनमासारम्भकालहोरेशस्य । अब्दाधिपत्यं च सावनाब्दप्रथमदिनाद्यहोरेशस्य ।

त्रयोदशदिनेनोनं कलियातदिनं भजेत् ।
360
त्रिशता, खांशरामैश्च द्वित्रिघ्नं सप्तभिर्हृतम् ॥
मासपो वर्षपस्तमादित्युक्तं जातके **यतः ॥**

353 48,81,23,318
तेषां 'त्रीष्वग्नयो''ष्टैकसुराकष्टिाहिसागराः' ।
754 494 601
मन्दोच्चानां 'कृतेष्वश्वा' 'वेदताना' 'कुखर्तवः' ॥६॥
272 54 23,22,96,745
'द्विभान्य''ब्धीषवो'ऽ'र्थाब्ध्यद्यूङ्गाङ्काश्विरदाश्विनः'[4] ॥ ७a ॥

मूलम्— 1. D. F. का for क

व्याख्या—1. Ms. defective. It reads : एतस्तत्र कना -gap- होरा

2. The Ms. reads श्रवश्रे for श्रवणे

3. Ms. reads वृत्तेगे for वृत्तौ गते

4. The Ms. exhibits a big gap from here to a part of the com. on verse 16, below p. 13.

'द्विमान्य''ब्धीषवो'[1]'ऽर्थाब्ध्यग्यङ्का'[2]'ङ्काश्विरदाश्विनः'।
[3]'वेदाग्नीभा''द्विशून्याङ्का'[4]'स्तत्त्वेभा' 'ऋतुषट्स्वराः' ॥ ७ ॥

प्रत्यग'श्वेष्वगा'श्चन्द्रात् पातानां ; तद्ग्रहान्तरात् ।

[परमविक्षेपकलाः]

[5]धृत्य-ङ्ग-मूर्च्छना-ऽब्धी-श-नागाः स्वांशाङ्घ्रयोऽर्धयोः[6] ॥ ८ ॥

क्षेपा मन्दोच्चवृत्तानां ;

[मन्दपरिधयः शीघ्रपरिधयश्च]

स्वांशैस्तान्यार्धपञ्चमैः ।
त्र्य-श्वा-ष्टी-न्द्रा-हि-रामा-शाः सूर्यात् ; शैघ्राणि भूसुतात् ॥ ९ ॥

'त्र्यर्था' 'रूपगुणा' 'भूपा' 'गोबाणा' 'नव' तुङ्गतः ।
द्वि-द्व्ये-क-द्व्ये-क-हीनास्तेऽप्योजयुग्मपदादिषु ॥ १० ॥

[युगमानम्]

युगं कल्पसहस्रांशो मनुस्तान्येकसप्ततिः ।
सन्धयः कृततुल्यास्तदाद्यन्ताभ्यन्तरेष्वपि[7] ॥ ११ ॥

मूलम्— 1. D. E. F. द्विभाग्न्य इषवो (corrupt).

2. A. र्थाह्यश्वाङ्का ; B. C. र्थाब्ध्यश्वाङ्का ; D. E. F. र्थाश्वाग्र्यङ्का (corrupt).

3. G. verses 7c-16 broken away.

4. D. F. शून्याङ्क

5. A. 8c to 12 frayed out.

6. D. F. स्वांशाङ्घ्रियोः (corrupt).

7, D. E. F. न्तरेष्विति

युगस्यापि दशांशोऽब्धि-त्रि-द्वये-क-घ्नः कृतादि च ।
अष्टाविंशे[1] युगे[2] तिष्यः सप्तमस्य मनोरयम् ॥ १२ ॥

[भगणांशाः]

द्वादश-त्रिंश-षष्ट्यंशा भगणाद् भांशलिप्तिकाः ।

[ग्रहयोजनभुक्तिः]

[3]ग्रहयोजनभुक्तिः स्याद् दशघ्नेन्दोः[4] कलागतिः ॥ १३ ॥

[भूमीन्दुरविव्यासाः]

भूगोलः[5] 'खेषुदिग्व्यासो' भमध्ये व्योम्न्यधः स्थितः[6] ।
'तिथ्यग्नि'[7]योजनश्चन्द्रो 'दिग्वेदाब्धि'मितो रविः ॥ १४ ॥

[अवन्तीस्थानम्]

उदक् पञ्चदशेऽवन्ती लङ्कायाः परिधेर्भुवः ।

[नक्षत्रपरिधिः]

रवेः षष्टिगुणे[8] भानि प्रत्यगीरयति ह्यतः ॥ १५ ॥

[अपक्रमवृत्तस्थितिः]

भगोलमध्यवृत्तार्धे वायुगोलस्य मध्यतः ।
अपक्रान्ते चतुर्विंशत्यंशैः सौम्यतराशयोः[9] ॥ १६ ॥

... ... [1]तेषां द्वादशाराणामन्तरालगता ये द्वादशापक्रममण्डलखण्डाः तेषामेव न केवलं मेषादिराशित्वम् । तं तं खण्डमभितः यद्यद् द्वयोर्द्वयोर्मण्डलतलार्धयोर्विवरं तत् कृत्स्नमपि तत्तद्राश्यात्मकमेव ।

मूलम् — 1. F. अष्टविंशे 2. D. E. F. युगो
3. D. दश for ग्रह (corrupt). Ms. C commences from here.
4. C. न्दु for न्दो 5. D. F. भूगोलं (wr.)
6. D. स्थिति: (wr.) 7. E. त्रिथ्यग्नि (corrupt)
8. A. षष्टिगुणो 9. D. E. तरांशयो:

व्याख्या—1. Ms. commences here after the gap.

[अयनचलनम्]

'भां'शैश्चलति तद्योगः प्राक्प्रतीच्योः पृथक् पृथक् ।
वृद्धिह्रासश्च दिव्याब्दैः पञ्चभिश्च क्रमोत्क्रमात् ॥ १७ ॥

तत्र निरक्षदेशे मीनमेषसन्ध्युदये पूर्वोक्तानि तन्मण्डलानि अपमण्डल-तिर्यञ्चि बध्नीयात् । तानि षड अपमण्डलतुल्यान्येव । तेष्वेकं पूर्वापर-स्वस्तिकलग्नं उत्तरस्वस्तिकादूर्ध्वं दक्षिणस्वस्तिकादधश्च दक्षिणोत्तरमण्डले परमापक्रमतुल्यान्तरे बध्नीयात् । द्वितीयमपि दक्षिणोत्तरमण्डले प्रथममण्डल-सम्पात एव सम्पातं कृत्वा अपक्रममण्डले मेषान्ते तुलान्ते च बध्नीयात् । तयोः प्राग्दिग्गतमन्तरालं कृत्स्नं मेषादिराशिः, प्रत्यग्गतं कृत्स्नं तुलादिराशिः । प्रथमद्वितीयसम्पातयोरेव च तृतीयमपि वृषकीटान्तयोर्बध्नीयात् । एवमेव अन्यानि त्रीण्यपि अपक्रममण्डलद्वादशांशान्तरालानि बध्नीयात् । एवं द्वादशविवराणि कृत्स्नशो द्वादश राशयः स्युः । अत उक्तम्—

यत्र क्वापि च दृष्टं ज्योतिर्मेषादिराशिगं तस्मात् ।
(गोलसारः, २. ८ c-d) ॥ १६ ॥

तत्र भगोलावयवानां वायुगोलावयवैः सह सम्बन्धो न नियत इति वायुगोलावयवेषु भगोलावयवानां संयोगविप्रयोगप्रकारः प्रदर्श्यते—

27
'भां'शैश्चलति तद्योगः प्राक्प्रतीच्योः पृथक् पृथक् ।
वृद्धिह्रासश्च दिव्याब्दैः पञ्चभिश्च क्रमोत्क्रमात् ॥१७॥

इति ।

तद्योगः प्रकृतयोर्घटिकापक्रममण्डलयोर्योगः चलति स्पन्दते । कथम् ? प्राक्प्रतीच्योः पृथक् पृथक् भांशैश्चलति । स यदा प्राक् चलति तदा अयनचलनम् ऋणम् । तत् सप्तविंशतिभागान्तम् । तथा प्रत्यक् चलनं धन[मपि][1] तावत् स्यात् । एवम् मीनमेषसन्धिमभितः चतुष्पञ्चाशद्भागानां घटिकामण्डलगतै-स्तावद्भिरंशैः सम्बन्धः स्यात् । एवं जूककन्यागतानामपि तावतां तावद्भि-र्घटिकामण्डलांशैः सह संयोगः स्यात् । कियता कालेन सप्तविंशतिभागचलनं इत्याह—

वृद्धिह्रासश्च दिव्याब्दैः पञ्चभिश्च क्रमोत्क्रमात् ॥ १७ b ॥

व्याख्या—1. Ms. ऋणम — for धनमपि

पञ्चभिर्दिव्याब्दैः ऋणं परिपूर्णं स्यात्। पुनश्च पञ्चभिः कृत्स्नस्य क्षयश्च स्यात्। एवमात्मकमपि ऋणं धनं वा यावता कालेन यावद् वर्धते तत् पुनरुत्क्रमेण तावता कालेन तावद्धीयते। पञ्चमे दिव्याब्दे यावती वृद्धिः षष्ठे ह्रासश्च तावानेव इत्यादि द्रष्टव्यम्। तेन विषुवत्प्रत्यासन्नानां नक्षत्राणां दक्षिणोत्तरदिक्चलनं ईषदधिकमेव विंशतिभागात्मकं स्यात्। तत्र चित्रायाः कन्यातुलासन्धिस्थत्वाद् अयनचलनाभावे भुजाया अप्यभावात् कन्यातुला-सन्धेरपक्रमस्याप्यभावः। ततश्चित्रायाः स्वक्षेप एवापक्रमः। तद्विक्षेपचापं च भागद्वयं सूर्यसिद्धान्ते स्मर्यते याम्यदिक्का—"दक्षिणे रुद्रयमलाः" (सूर्यसि० ८.७) इति। हस्तचित्रयोः क्रमेण एकादशभागा भागद्वयं च क्रमाद् विक्षेपावित्यर्थः।

ऋणात्मकायनचलनपरिपूर्तौ तु राशिषट्काद् भांशेषु त्यक्तेषु भाग-त्रयाढ्यं राशिपञ्चकं शिष्यते। तत उदग्गोलगतस्तदपक्रमः। तद्भुजा च राश्यष्टमांशतुल्यचापभागसप्तकः सपञ्चमांशः[1]।

अत्र सप्तममपक्रमचापं करोतीति तदन्तरं च द्व्यशीतिः। तत्पञ्चमांशः षोडशकलाः सावयवाः। तत्संयुक्तं 'सङ्कृतम्' (६३७') इति। तद्विक्षेपचापयोः दिग्भेदात् ततो भागद्वयगते विक्षेपे त्यक्ते सति शिष्टं अष्टौ भागाः, षट्त्रिंशत् कलाश्च (८° ३७')।

धनायनचलने परिपूर्णे तु दक्षिणगोलगतं भुजाचापम्। अपक्रमचापं च पूर्वोक्तमेव। तद्विक्षेपयोर्दिगैक्यात् तत्संयोगस्फुटो दक्षिणापक्रमः, द्वादश भागाः सप्तत्रिंशत्कलाश्च (१२° ३७'). ततस्तत्संयोगः सपादा एकविंशति भागाः। परमायनचलनकालयोर्मध्याह्नप्रदेशान्तरालचापं तद्दक्षिणोत्तरमण्डल-गतं कृत्स्नं सममण्डलाद् दक्षिणगतमेव प्रायशो भारतखण्डे। कन्याकुमार्या दक्षिणतः सिंहलादिष्वेव दक्षिणोत्तरशलाकयोः खण्डशः (?) स्युः।

रेवत्या अपि मीनान्तात् प्रत्यक् कलादशकान्तरस्थत्वात् दक्षिणोत्तर-मण्डले सपादैकविंशतिभागाः द्वयोः कालयोर्मध्याह्नश्चान्तरालगताः स्युः। रेवत्यास्तु विक्षेपचापं सौम्यं भागपञ्चकं स्मर्यते। ततस्तद्विक्षेपद्वययोगस्तदप-क्रान्तकलाचतुष्कोनः सदापि। रेवती च तयोर्मध्याह्नच्छायान्तरम्। अगस्त्यस्य तु मिथुनान्तगतत्वात् पादोनं भागत्रयमेव अयनचलनहेतुकं दक्षिणोत्तरमण्डल-गतं चलनं स्यात्। एवं कर्किद्वितीयभागस्थस्य[2] पुनर्वसोरपि तद्वदुदग्विक्षेपस्य भागषट्कत्वाद् अवन्त्यां सममण्डलादुत्तरत एव सर्वदा मध्याह्नप्राप्तिः।

व्याख्या—1. The Ms. reads सप्तकं सपञ्चमांशम्।

2. The Ms. reads भागस्थः स्यात् for भागस्थस्य

'संवृतार्थः सञ्चिन्त्यः' (१६,७७,६४७) [कलि० ४५९३, A. D. १४९१] इति कल्यहर्गणे चन्द्रः चित्रामाच्छादयत्। 'उडु-त्वाष्ट्रमिन्दुसुताढ्यम्' (१६,७८,५२४-३०) (कलि० ४५९५, A. D. १४९३) इति नाडयाद्यहर्गणे चित्रायाः उदक्पार्श्वगतो बुधः परेद्युसमोपरिदृष्टकृत्तिकास्थितेऽर्केऽह्नि चन्द्रदक्षिणपार्श्वग[त]: 'लीनन्निळस्थितोऽयम्' (१६,७९,००३)(कलि० ४५९६, A. D. १४९४) इत्यहर्गणे चन्द्रान्मुक्ता रोहिणी दृष्टा समोपरिष्ठा। तस्मान्नक्षत्राणामपि ग्रहवत् स्वभागादेरयनचलनं संस्कृत्य अपक्रमं गहीत्वा तद्विक्षेपयोः योगं वियोगं वा कृत्वा स्फुटापक्रमो ज्ञेयः। तेन छायादिकं च ग्रहवत् कुर्यात्।

तस्मात् ज्योतिस्समुदायस्य कृत्स्नश एव चलनम्, नापक्रममण्डलमात्रस्य। तस्मान्नक्षत्राणामन्योन्यं विवरं सर्वदा सममेव। प्रत्येकविक्षेपश्च सर्वदा सम एव। अपक्रममण्डलासन्नानि पञ्चषभागविक्षेपान्येव शुक्रादिभिश्छाद्यानि। ततो विप्रकृष्टानां विक्षेपाः योगभागाश्च यन्त्रैरेव [आनेयाः।] तस्माद्—

[अ]शीतिभागे याम्यायामगस्त्यो मिथुनान्तगः।

इत्यादिस्मृतिरपि प्रत्यक्षमूलैव।

ननु ज्योतिश्चक्रस्य कृत्स्नस्यापि प्राक्प्रतीच्योश्चलने तत्स्थानां ज्योतिषामुदयकालो भिद्येत। तेन आर्क्षदिवसानामपि महत्त्वमल्पत्वं च स्यात्। तत्रायनचलनसाधनमध्यमस्य मकरादित्वे सावनदिवसा आर्क्षाश्चाल्पाः प्रत्यक्चलनाद् भगोलस्य, कर्क्यादौ तु प्राक्चलनात् महान्तश्च स्युः। तथा च ग्रहाणामप्युदयादिकालभवत्वाय यः कश्चित्संस्कारः कार्यः स्यात्, स च क्वापि नोक्त इति चेत्—यदि प्राक्प्रतीच्योश्चलनं, तर्हि तच्चलनांशान् लिप्तीकृत्य स्वगत्या हृत्वा चक्रलिप्ताप्ताः कलाः तन्मध्यमे मेषादौ ग्रहमध्यमेषु स्फुटेषु [ततः][1] शोध्याः, तुलादौ योज्याश्च।

तर्हि स च वक्तव्यः। स च सूर्यसिद्धान्तादिषु नोक्तः, तच्चलनानयनमेवोक्तम्। अतः कल्प्यते भगोलस्य न प्राक्प्र[ती]च्योश्चलनम्। कस्य तर्हि? घटिकापक्रममण्डलयोगस्यैव प्राक्प्रतीच्योश्चलनम्। अत उक्तम्—'भांशैश्चलति तद्योगः प्राक्प्रतीच्यो'रिति।

तर्हि भगोलस्य वा वायुगोलस्य वा उभयोर्वा चलनम्? भगोलस्य चेत् प्रथमं मीनमेषसन्धेः दक्षिणतश्चलनं, कन्यातुलासन्धेरुत्तरतश्चलनं युक्तम्। यतस्तथा सत्येव मेषतुलयोरादितःप्रभृत्युपर्युपरिप्रदेशस्य घटिकामण्डलावयवेनापि उपर्युपरिगतेन सह सम्बन्धः स्यात्। तन्मध्यमस्य तुलादित्वे विषुवद्वयस्य

व्याख्या—1. The Ms. reads वता for ततः

[विदितकाले अयनस्थितिः]

कलिसन्ध्याष्टमांशे स्वशतांशाद्वये गते ततः[1] ।
धनुर्मिथुनयोर्मध्ये प्रायशस्त्वयने उभे ॥ १८ ॥

व्यत्ययेन चलनात् उभयोर्मण्डलयोरपि प्रत्यगयनचलनतुल्यान्तरे संयोगः स्यात् । ततश्च अयनचलनाज्जायमानो विशेषः संस्कृतायनरविबाहुजचरप्राण कलान्तर-संस्कारयोरेवान्तर्भवति । घटिकामण्डलस्य चलने पूर्वापरदिशोः तद्वशात् कालतो भेदः स्यात् । स च नोपलभ्यते । अतो न वायुगोलस्य, नोभयोरपि । तस्माद् भगोलस्यैव चलन-मिति सिद्धम् ॥ १७ ॥

तत् स्वकाले कियदित्याह—

कलिसन्ध्याष्टमांशे स्वशतांशाद्वये गते ततः ।
धनुर्मिथुनयोर्मध्ये प्रायशस्त्वयने उभे ॥ १८ ॥

इति । दिव्याब्दशतमिता खलु काले सन्ध्या स्मर्यते । तस्याष्टमांशः सार्ध-दिव्याब्दद्वादशकः । स च सौराब्दानां पञ्चचत्वारिंशत्-शतमितः, तस्य शतांशः पञ्चचत्वारिंशदब्दः । ततः **स्वशतांशाद्वयः सन्ध्याष्टमांशः** 'शिव शिव' (४५४५) इति कल्यब्दैस्तावति याते **उभे अयने** उत्तरदक्षिणाख्ये **प्रायशो धनु-मिथुनमध्ये स्तः । तदा अयनचलनांशाः धनात्मकाः पञ्चदशसंख्या बभूवुः ।** प्रायिकत्वं च कलाष्टकाधिक्यात् । यतो **भार्गव-परमेश्वराचार्येण अस्मत्परमगुरुणा** 'चलांशा-स्त्वम्' (४५३६) इति कल्यब्दे परीक्ष्य पञ्चदशांशपूर्तिर्निर्णीता । अतः सन्ध्याष्टमांशशतांशस्य वा प्रायिकत्वम् । स्वजन्मकालज्ञापनार्थं चैवमुक्तम् । तदाहर्गणश्च 'त्यजाम्यज्ञतां तर्कैः' (१६,६०,१८१) (A. D. १४४३) इति ।

ननु तदा **सूर्यसिद्धान्ते** अयनचलनांशाः चतुर्दशैव सार्धा दशकलाश्च । ततोऽत्रोक्तम्—"सार्धकलोनांशकाधिकम्" इति । नैष दोषः । तत्रोक्तस्य गणितस्य स्थौल्यं स्वयमेव ख्यापितम्, पुनः परीक्षणेन निर्णयस्य प्रदर्शनात् । अतः सिद्धम्—"परीक्षणेनैव तद्व्यक्तिः" इति । **मानसोक्तं** तु—द्वाविंशति-कलाधिकांशकपञ्चदशकम् । **अन्यैः** कैश्चित् प्रदर्शितं ततोऽप्यधिकम् ॥ १८ ॥

एवंभूतभगोलावयवविशेषेषु भादिषु रवीन्द्वादिचारवशादवगतेषु तारा-तिथ्यृतुमासायनादिकालविशेषेषु श्रौतस्मार्तकर्माणि विधीयन्ते । तच्चारश्च मध्यमचाराद् भिन्न इति मध्यमस्य स्फुटीकरणेनैव कालविशेषज्ञानं शास्त्र-

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मूलम्— 1. D. गतेस्ततः (corrupt)

[मन्दशीघ्रवृत्तानि]

ग्रहभ्रमणवृत्तानि गच्छन्त्युच्चगतीन्यपि ।
मन्दवृत्ते[1] तदर्केन्द्वोर्घनभूमध्यनाभिकम् ॥ १९ ॥

मध्यार्कगति चान्येषां तन्मध्यं शीघ्रवृत्तगम् ।
तेषां शैघ्र्यं[2] भचक्रान्न विक्षिप्तं गोलमध्यगम् ॥ २० ॥

शैघ्रत्वेन तदंशैः स्वं प्रमायोक्तं ज्ञशुक्रयोः ।
मन्दवृत्तस्य चैवात्र क्षयवृद्धी स्वकर्णवत् ॥ २१ ॥

प्रयोजनं स्यात् । मध्यमस्फुटादिविवेकश्च गोल एव प्रदर्श्य इति गोलस्वरूपं संक्षेपतः प्रदर्श्य तद्गतानि स्फुटोपयोगीनि मण्डलानि प्रदर्शयति—

ग्रहभ्रमणवृत्तानि गच्छन्त्युच्चगतीन्यपि ।
मन्दवृत्ते तदर्केन्द्वोर्घनभूमध्यनाभिकम् ॥ १९ ॥

मध्यार्कगति चान्येषां तन्मध्यं शीघ्रवृत्तगम् ।
तेषां शैघ्र्यं भचक्रान्न विक्षिप्तं गोलमध्यगम् ॥ २० ॥

शैघ्रत्वेन तदंशैः स्वं प्रमायोक्तं ज्ञशुक्रयोः ।
मन्दवृत्तस्य चैवात्र क्षयवृद्धी स्वकर्णवत् ॥ २१ ॥

तद् **ग्रहभ्रमणवृत्तं**, ग्रहो यत्र भ्रमति तत्र ग्रहभ्रमणवृत्तम् । ग्रहाणां बहुत्वात् तद्भ्रमणवृत्तान्यपि बहूनि स्युः इति बहुवचनप्रयोगः । तान्यपि **गच्छन्ति** । 'अपि'शब्देन ग्रहाः समुच्चीयन्ते । तानि कियद्गतीनि इत्याह— **उच्चगतीनीति** । उच्चस्य गतिर्येषां तानि उच्चगतीनि । क्व पुनस्तानि गच्छन्तीत्यत आह—**मन्दवृत्त** इति । भचक्रलिप्ताशीत्यंशैः त्रि(३)-अश्व(७)-अष्टया(१६)दिभिः परिमितं स्वं स्वं प्रतिमण्डलं भ्रमति । तच्च क्वावतिष्ठत इत्याह—**तदर्केन्द्वोर्घनभूमध्यनाभिकमिति** । घनभूमध्यमेव नाभिर्यस्य तद् घनभूमध्यनाभिकम् । अर्केन्द्वोः मन्दवृत्तमेव घनभूमध्यनाभिकम्, नान्येषाम् । तेषां नानादेशनाभिकमेव । केषु देशेषु तर्हि तन्मध्यम् इत्याह—

मध्यार्कगति चान्येषां तन्मध्यं शीघ्रवृत्तगम् ॥ २० a ॥

मूलम्— 1. G. मान्दे वृत्ते 2. A-F. शैघ्रं

इति। अन्येषां मन्दवृत्तान्यपि भ्रमन्त्येव, न क्वचिदेवावतिष्ठन्ते। तेषां भ्रमतां क आधार इत्यत्राह—तन्मध्यं शीघ्रवृत्तगम् इति। तत्र च कियती गतिरित्याह—मध्यार्कगतीति। एतदुक्तं भवति—कुजादीनां मन्दवृत्तानां भ्रमतां रविपर्यया एव पर्ययाः। ते च स्वस्वशीघ्रोच्चपरिधौ मध्यं कृत्वा भ्रमन्ति। आदित्यमध्यगतिरेव तन्मन्दपरिधीनामपि गतिः। अत एव पञ्चानाम् आदित्यमध्यमेव शीघ्रोच्चम्। तेषां गतिमन्तो[1] वा गतयो वा शीघ्रपरिधयः। अगतिकाश्चेत् क्व कथं वा तिष्ठन्तीत्याद्याकाङ्क्षायामाह—

तेषां शैघ्र्यं भचक्रान्न विक्षिप्तं गोलमध्यगम्॥ २० b॥

इति। तेषां शैघ्र्यवृत्तं सदापि गोलमध्यगमेव, न भ्रमति, न च विक्षिप्यते, भचक्रात् अपमण्डलात्। मन्दोच्चवृत्तानामेव स्वस्वपातगतिवशाद् विक्षेपोक्तेः,

धृत्य-ङ्क-मूर्च्छना-ऽधी-श-नागाः स्वांशाङ्घ्रयोर्द्वयोः॥

क्षेपा मन्दोच्चवृत्तानाम्। (सि० दर्पणम्, ८-९)

इति। तस्मात् सर्वेषामपि शीघ्रवृत्तं सदापि अपक्रममण्डलसमाननाभिकं तन्मार्ग[ग]मेव च। तत्परिधिगतनाभिकं मन्दवृत्तमेवापक्रममण्डलमभितोऽर्धशो विक्षिप्यते।

ज्ञशुक्रयोर्विशेषमर्धेनाह—

शीघ्रत्वेन तवंशैः स्वं प्रमायोक्तं ज्ञशुक्रयोः॥ २१ a॥

इति। बुधशुक्रयोः स्वभ्रमणमेव शीघ्रपरिधित्वेनोक्तम्। तर्हि चक्रांशतुल्यमेव तत् सदा स्यादिति। नेत्याह—तवंशैः वस्तुतः शीघ्रवृत्तभूतस्य षष्टिशतत्रयांशैः प्रमाय स्वभ्रमणवृत्तं शैघ्रतयोक्तम्, स्वप्रतिमण्डलात् शीघ्रवृत्तस्य महत्वात्। अन्येषां त्रयाणां प्रतिमण्डलादल्पमेव शीघ्रवृत्तम्। तन्निमित्तं स्फुटकर्मविशेषं युक्तिभागे वक्ष्यति—

ग्रहोच्चयोर्विपर्यस्तौ भोगावप्यत्र कल्पयेत्। (सि० दर्पणम्, २४)

इति।

उत्तरार्धेन सप्तानां मन्दवृत्तेषु अनुवृत्तं शीघ्रवृत्तेभ्यो व्यावृत्तं विशेषमाह—

व्याख्या—1. The ms. reads गतिमतो

२. न्यायभागः

[प्रतिमण्डलं कक्ष्यामण्डलं च]

ज्ञातभोगग्रहं वृत्तं सर्वत्र प्रतिमण्डलम् ।
कक्ष्यावृत्तं च तत्तुल्यं ज्ञेयभोगप्रदेशगम् ॥ २२ ॥

मन्दवृत्तस्य चैवात्र क्षयवृद्धी स्वकर्णवत् ॥ २१b ॥

इति । **अत्र,** स्फुटहेतुषु द्वादशसु परिधिषु मध्ये **मन्दवृत्तानां** सप्तानामेव **स्वकर्णवत्** स्वस्वमन्दकर्णवत् **क्षयवृद्धी** स्तः, न शैघ्राणाम् । अयमेव मन्दशीघ्रकर्मणो-र्विशेषहेतुः । विक्षेपश्च मन्दक्षेत्रगतानां वृत्तानामेवेति मन्दस्य शैघ्रादप्यधिकं धर्मद्वयं विद्यते ॥ १९-२१ ॥

एवमुपदेशभागमुपसंहृत्य न्यायभागं च संक्षेपतः प्रदर्श्यते । आप्त-वचनात् प्रत्यक्षपरीक्षणैर्वायं भागो ज्ञेयः । वक्ष्यमाणस्तु बुद्धिमतां स्वयं निरूप्यैव ज्ञातुं शक्यम् । तथापि शिष्याणां लाघवाय तद् दिङ्मात्रं प्रदर्श्यते ।

तत्र प्रथमं स्फुटन्यासं लम्बनादिष्वतिदिशति—

ज्ञातभोगग्रहं वृत्तं सर्वत्र प्रतिमण्डलम् ।
कक्ष्यावृत्तं च तत्तुल्यं ज्ञेयभोगप्रदेशगम् ॥ २२ ॥

सर्वत्र शैघ्रे मान्दे च कर्मणि, चन्द्रस्य द्वितीयस्फुटकर्मणि, लम्बने, सितमानानयने, चन्द्रमण्डलघनमध्यदृष्ट्यपेक्षया रविगत्यानयने, अन्यत्रापि। **ज्ञातभोगग्रहं वृत्तं प्रतिमण्डलम्** । ज्ञातो भोगो यस्य ग्रहस्य स ज्ञातभोगः, ज्ञातभोगो ग्रहो यस्य वृत्तस्य तद् वृत्तं ज्ञातभोगग्रहम् । यस्मिन् वृत्ते स्वपरिधिस्थघनमध्य-ग्रहस्य कल्पिताद् यतःकुतश्चि[त् स्थाना]देः प्रभृति ग्रहबिम्बघनमध्यपर्यन्तः प्रदेशो ग्रहभुक्तो ज्ञातः, तद् वृत्तं ज्ञातभोगग्रहमित्यर्थः । तद्वृत्तमध्यगतदृष्टेरेव दृग्गोलगतः ग्रहः तावद्राश्यादिकः स्यात् । तद्वृत्तमध्याद् विप्रकृष्टदृष्टेः पुनः तद्ग्रहपर्यन्तस्य दृग्गोले तद्ग्रहः कुत्र दृश्य इत्येतत् शीघ्रस्फुटन्यायेन ज्ञेयम् । योऽत्र द्वितीयो दृग्गोल उक्तः तद्व्यासार्धः स्फुटकर्मणि कर्णः । यत्तु ज्ञातभोग-ग्रहस्य प्रथमोक्तस्य व्यासार्धं तत् त्रिज्यास्थानीयम् । तत्तुल्यव्यासार्धमन्य-न्मण्डलं ज्ञेयभोगप्रदेशमध्यग्रहसूत्रस्पृक्परिधिकं कल्प्यम् । तत् कक्ष्यावृत्तमिति **आर्यभटाद्यै**राख्यायते । एतत् स्फुटकर्मणि छायालम्बनादिषु च स्पष्टी-भविष्यति ॥ २२ ॥

त एवाप्युच्चनीचाख्ये बहिश्चेदितरेतरम् ।
तद्व्यासार्धान्तरे चान्ये तन्मध्यान्तरनिर्मिते ॥ २३ ॥

ग्रहोच्चयोर्विपर्यस्तौ भोगावप्यत्र[1] कल्पयेत् ।
तिर्यक्त्वे ज्ञेयभोगात्तत् कोटीव्यासदले तयोः ॥ २४ ॥

तत्रैव विशेषमाह—

त एवाप्युच्चनीचाख्ये बहिश्चेदितरेतरम् ।

तद्व्यासार्धान्तरे चान्ये तन्मध्यान्तरनिर्मिते ॥ २३ ॥

ग्रहोच्चयोर्विपर्यस्तौ भोगावप्यत्र कल्पयेत् ॥ २४ a ॥

इति । **ते** कक्ष्याप्रतिमण्डले, अन्योन्यं **बहिर्गतकेन्द्रे चेत् त एव उच्चनीचाख्ये** स्तः । तदा **अन्य**कक्ष्याप्रतिमण्डले **तन्मध्यान्तरनिर्मिते** स्तः । तच्छब्देन उच्चनीचाख्यत्वमापन्ने उच्येते । तन्मध्ययोरन्तरालं तन्मध्यान्तरम् । तत्तुल्येन व्यासार्धेन भ्राम्यमाणेन निर्मिते द्वे वृत्ते तदा कक्ष्याप्रतिमण्डले स्तः । तन्मध्ययोरन्तरं च कियदित्याह— **तद्व्यासार्धान्तरे** इति । उच्चनीचत्वमापन्नयोर्वृत्तयोरुभयोस्तुल्यं व्यासार्धं यावत् तावदेव पुनः कल्पितयोः कक्ष्याप्रतिमण्डलयोर्मध्ययोरन्तरालमित्यर्थः ॥ २३ ॥

ज्ञेयभोगग्रहस्य ज्ञातभोगग्रहस्य च कथंभूतः सम्बन्ध इत्याह इत्येतच्चोपरितनेन ग्रन्थेन—

ग्रहोच्चयोर्विपर्यस्तौ भोगावप्यत्र कल्पयेत् ।

तिर्यक्त्वे ज्ञेयभोगात्तत् कोटीव्यासदले तयोः ॥ २४ ॥

किञ्च— **अत्र** उच्चनीचवृत्तात् स्वभ्रमणवृत्तस्याल्पत्वेन उच्चनीचवृत्तत्वप्राप्तौ **ग्रहोच्चयोर्भोगावपि विपर्यस्तौ कल्पयेत्** । स्वभ्रमणवृत्ते ग्रहभुक्ते राश्यादिकमुच्चं कल्पयेत् । स्वभ्रमणवृत्तमध्येन वृत्तान्तरेण भ्रमता तत्र भुक्तं राश्यादिकं मध्यमं च कल्पयेत् इत्येतावानेव विशेषः ।

पुनरपि नियतगतीनां तद्गतिहेतुभूतानामपि नियतगतित्वे सत्यपि आकृतिपरिमाणादिवशात् सम्भवन्न्यायान्तरमाह—

तिर्यक्त्वे ज्ञेयभोगात्तत्कोटी व्यासदले तयोः ॥ २४ b ॥

मूलम्— 1. D. E. F. भागावप्यत्र

दोर्भेदो वा युतिः क्षेपस्तन्मध्यग्रहगोलगः ।

[भुजादिलक्षणम्]

[1]दोःकोटिभुजयोर्योगः कर्णबाहु[2]चतुर्भुजः ॥ २५ ॥

दोर्भेदो वा युतिः क्षेपस्तन्मध्यग्रहगोलगः ॥ २५ a ॥

इति ।

तत्र **ज्ञेयभोगमण्डलापेक्षया** ज्ञातभोगमण्डलस्य **तिर्यक्त्वे तद्व्यासार्धस्य** इतरव्यासार्धदिगपेक्षया तिर्यक्त्वात् कर्णत्वं प्राप्तस्य या कोटिः तत्तुल्य एव कक्ष्याप्रतिमण्डलयोर्व्यासदलस्थतद्वृत्तस्यापि, भ्रमतः तन्नाभिगमनमार्गगं यद्वृत्तं तस्यापि । ज्ञेयभोगातिर्यक्त्वे तत्कोटिरेवोच्चनीचव्यासार्धतया कल्प्या । ये पुनरुभयोर्भुजे तद्योगतुल्य एव ज्ञेयमण्डलात् तद्ग्रहस्य क्षेपश्च । कदाचिद् भुजयोर्वियोगश्च विक्षेपः स्यात् । एतत्सर्वमुपरिष्टादुदाहरणेन स्पष्टीकरिष्यति (?भविष्यति) ॥ २४-२५ a ॥

एवमेकस्यैव ग्रहस्य द्रष्टृदेशवशात्सम्भवं नानादर्शनन्यायं कृत्स्नं संक्षेपतः प्रदर्श्य तत्क्षेत्रगतगणितन्यायमपि प्रदर्शयति । तत्र एकेनार्धेन अखिलक्षेत्रस्य गणितस्य बीजभूतं भुजाकोटिकर्णक्षेत्रगणितन्यायः प्रदर्श्यते—

दोःकोटिभुजयोर्योगः कर्णबाहुचतुर्भुजः ॥ २५ b ॥

इति ।

यस्मिन् क्षेत्रे भुजाकोटिकर्णेषु त्रिषु, ज्ञाताभ्यां द्वाभ्यां, इतरेतरज्ञानोपायो जिज्ञास्यते, तत्र त्रीणि समचतुरश्रक्षेत्राणि कल्प्यानि । तत्रैकस्य चत्वारो बाहवो जिज्ञासिताः क्षेत्रबाहुना तुल्याः, अन्यस्य कोट्या तुल्याः, अन्य[स्य] कर्णतुल्याः । तत्र कर्णतुल्यबाहुक्षेत्रं इतरचतुरश्रद्वययोगसमम् ।

स्वसंवेद्यं चैतत् प्रतिभाजुषाम् । कथम् ? तत्र समचतुरश्रक्षेत्रं वीक्षमाणस्य तत्पर्यन्तभागेभ्यश्चतुर्भ्यस्तुल्येभ्यो भुजाख्येभ्यः एकान्तरितकोणयोरन्तरस्य कर्णाख्यस्य दैर्घ्याधिक्यं प्रथमं स्फुरेत् । बाहुष्वपि मिथःसंस्पृष्टैकाग्रयोर्द्वयोर्द्वयोरितरेतरं विपरीतदिक्कत्वे च ज्ञाते कर्णद्वयस्य सामान्येन (?समानेन) भाव्यम्, परिमाणभेदस्य कारणाभावाद् इति च स्फुरेत् । तयोरेकतरकर्णदिगभिमुखस्य तस्याऽऽयामत्वाङ्गीकारे इतरकर्णाग्रद्वयस्य कटाक्षस्य तत्समायामविस्तारं कोणप्रतिकोणान्तसमबाहुकं पूर्वचतुरश्रगर्भं चतुरश्रान्तरं प्रतीयेत । तत्र यदि प्रथमस्य बाहवो दिगभिमुखाः, तर्हि द्वितीयस्य विदिगभिमुखाश्चत्वारः ।

मूलम्— 1. In D. E. F., this line is transposed to after verse 26.

2. B. gives तुल्य below बाहु as an alt. reading.

तत्र प्रथमस्यैकैकं बाहुमभितो ये द्वे त्र्यश्रे उत्पद्येते, तत्र प्रथमचतुरश्रान्तर्गतमेकम्, तद्बहिर्गतमन्यत्। एवं प्रथमस्य प्रतिबाहु द्वे द्वे त्र्यश्रे स्तः। तान्यष्टौ सर्वाणि मिथस्तुल्यान्येव। तेषां प्रत्येकं फलं च प्रथमचतुरश्रफलचतुरंशतुल्यम्, कर्णाभ्यां चतुर्धा विभक्तस्य प्रथमचतुरश्रस्य खण्डैश्चतुर्भिस्तुल्यत्वात्। तद्बहिर्गतानां च ततस्तयोरन्तर्गतचतुरश्रफलाद् द्विगुणं बहिर्गतचतुरश्रफलम्। चतुरश्रक्षेत्रफलं च तद्बाहुवर्गसमम्। तस्तात् तत्तत्समचतुरश्रबाहुवर्गाद् द्विगुणं तत्कर्णभुजक्षेत्रफलम्, फलमूलतुल्यं च बाहुदैर्घ्यम् इत्येतत्सर्वं द्रव्यभूतस्य पुरुषस्यावश्यं स्फुरति, तस्य संवेद्यसम्बन्ध्यखिलन्यायावयवानां तत्त्वज्ञानपर्यन्तं जिज्ञासाया अविश्रान्तेः।

एवं समचतुरश्रकर्णज्ञानानन्तरमेव आयतचतुरश्रकर्णजिज्ञासा स्यात्। तस्य भुजाकोटयोरतुल्यपरिमाणत्वात् तयोः कतरस्य वर्गं द्विगुणितं तत्फलं स्यादित्यत्र सन्देहच्छेदिविशेषहेत्वभावात् तद्योगार्धस्य द्विगुणीकरणे तदैक्यमेव तत्फलं स्यात् इति स्फुरणस्य ऊहत्वात् तदेव वास्तवं फलम्, ततोऽल्पं वाऽधिकं वा, इति संशयः स्यात्। ततस्तन्निर्णयार्थं पुनरपि निरूपयति। तत्र निरूपणस्य द्वौ मार्गौ। द्वयो राश्योर्वर्गमूलं निरवयवम् एकादिसंख्याविशेषेषु कयोः कयोः स्याद् इति संख्या [निश्चीयते।] तदन्वेषण एको मार्गः। अशेषविषयव्यापी क्षेत्रच्छेदकद्वारोऽन्यो मार्गः। प्रथममनेन मार्गेण गन्तव्यम् अन्यस्य [अर्थात् प्रथमस्य] अल्पविषयत्वाद्, आनन्त्यात् क्वचिदप्यविश्रान्तेश्च। तत्र कथं छित्वा योजने द्वित्रा वा सर्वे वा बाहवो जिज्ञासितकर्णतुल्याः स्युः? तत्र कोटितुल्यचतुरश्रस्य एकेन बाहुना अल्पस्य बाहुं कुतश्चित्कोणतः प्रभृति सन्धाय संश्लिष्टस्य क्षेत्रस्य यत्र कोणयोः संयोगः स भागो दोःकोटियोगतुल्यः। महति चतुरश्रे संश्लिष्टाद् बहिर्गतः खण्डो दोःकोटयन्तरसमः। इतरौ बाहू कोटितुल्यावेव। अल्पस्य चान्येन संस्पृष्टौ बाहू दोःसमावेव। एवं च पर्यन्तभागाः षोढा विभक्ताः स्युः। तत्र कोणयुतेर्महति दोःकोटयन्तरसमे लाञ्छने कृते दोःकोटियोगतुल्यस्य बाहोर्लाञ्छनाद् बहिर्गतो भागो दोःसमः, अन्यः कोटिसमः। महतोऽन्तरेणोनत्वात्, अल्पस्यान्तरेणाधिक्यात् कोटितुल्यत्वं च तयोः। महच्चतुरश्रं लाञ्छनमार्गेण छिन्द्यात्। तदा तदायतचतुरश्रदोःसमविस्तारं कोटिसमायामं च, इतरस्य खण्डस्याश्रे द्वे कोटिकोटितुल्ये, द्वे चतुरश्रतुल्ये, अन्ये दोःकोटयन्तरतुल्ये। तस्य शिखरे छित्त्वा पृथक्कृतो खण्डः दोःकोटयन्तरसमचतुरश्रं क्षेत्रम्। तच्छिष्टं चायतचतुरश्रं पूर्वेण तुल्यम्। तयोर्द्वयोः कर्णमार्गेण छिन्नयोः चत्वारि त्र्यश्राणि स्युः। तत्कर्णाश्चत्वारो जिज्ञासितकर्णतुल्या एव। तानि तथा सन्दध्याद् यथा तत्कर्णा बहिर्गताः स्युः। तथा तन्मध्यत्र्यश्रशून्यं यद्विवरं तद् दोःकोटयन्तरसमचतुरश्रम्। ततस्तत् तृतीयेन

कक्ष्यामध्योच्चनीचस्पृक्सूत्रखेटान्तरं भुजा ।
कोटिस्तदुच्छ्रितिः कर्णः कक्ष्यामध्याद् ग्रहान्तरम् ॥ २६ ॥

[ग्रहस्फुटः]

कर्णवृत्तांशदोश्चापयुतोनोच्चस्फुटो ग्रहः[1] ।
कर्णवृत्तांशबाह्वाद्यैर्मान्दे कक्ष्यैव[2] नीयते[3] ॥ २७ ॥

खण्डेन पूरणीयम्। तथा तत् जिज्ञासितकर्णसमबाहुकं समकर्णसमचतुरश्रं स्यात्। अतः सिद्धम्—

दोःकोटिभुजयोर्योगः कर्णबाहुचतुर्भुजः ॥ २५ b ॥

इति।

दोःसमचतुर्बाहुकस्य कोटिसमचतुर्बाहुकस्य च चतुरश्रयोरेकीकरणे चतुर्भुजं कर्णबाहुकं स्यात्। इत्येतत्सर्वं युक्तिमूलमेव, न त्वागममूलम्। ततः प्रतिभाजुषां चक्षुर्हस्तादिव्यापारं विना मनसा निरूप्य एवं निर्णेतुं शक्यम्। अनयैव दिशा विष्कम्भपरिधिज्याचापसम्बन्धश्च निरूप्यैव ज्ञेयः। एतत्सर्वं मया **आर्यभटीयव्याख्याने** (आर्यभटीयभाष्यम्, गोल० १७) प्रपञ्चितमिति विरम्यते ॥ २५ ॥

एवं स्फुटीकरणच्छायाग्रहणादिधारणभूतं भुजाकोटिकर्णन्यायं प्रदर्श्य स्फुटी[करण]कर्मणि च साराशं प्रदर्श्यते—

कक्ष्यामध्योच्चनीचस्पृक्सूत्रखेटान्तरं भुजा ।
कोटिस्तदुच्छ्रितिः, कर्णः कक्ष्यामध्याद् ग्रहान्तरम् ॥ २६ ॥
कर्णवृत्तांशदोश्चापयुतोनोच्चस्फुटो ग्रहः ।
कर्णवृत्तांशबाह्वाद्यैर्मान्दे कक्ष्यैव नीयते ॥ २७ ॥

इति।

तत्र प्रथमपद्येनावृत्त्या स्फुटक्षेत्रगतकर्णानयने विकल्पेन प्राप्तं प्रकारद्वयं दर्शयति।

मूलम्— 1. D. E. F. स्फुटग्रहः

2. A मन्दे कक्ष्यैव ; B. मन्दकक्ष्यैव

3. E. नीयताम्. The commentary in G also gives this as an alternative reading. G breaks off with this verse.

तत्र प्रथमं प्रतिमण्डलस्फुटे योज्यते। तत्रैतद्वाक्यस्य युक्तेश्चाज्ञः (?) स्यात्। **कक्ष्यामध्योच्चनीचस्पृक्सूत्रस्य**, कक्ष्यामध्योच्चनीचस्पृशः सूत्रस्य स्फुटीक्रियमाणग्रहस्य च यदन्तरमुच्चनीचसूत्रतिरश्चीनमध्यज्यात्मकं सा **भुजा**। कक्ष्यामण्डलमध्ये प्रतिमण्डलपरिधिस्थोच्चप्रदेशं नीचप्रदेशं च स्पृशति इति कक्ष्यामध्योच्चनीचस्पृगित्यत्र विग्रहः। वाक्यशेषयोजनमुभयत्र समानम्। **तदुच्छ्रितिः** भुजाया उच्छ्रितिः, **कोटिः**। उच्छ्रयश्च भूमध्याद् विप्रकर्ष एव सर्वेषाम्। तयोः **कर्णः** कक्ष्यामण्डलमध्यस्य ग्रहबिम्बमध्यस्य च विवरम्। ऊर्ध्ववदस्यापि प्रथममर्धमुभयत्र योज्यम्॥ २६॥

मन्दोच्चे शीघ्रोच्चे वा **कर्णवृत्तांशदोश्चाप**धनशोधनाभ्यां तत्तत्कक्ष्या-मध्यमण्डलमध्यदृग्गोलगते **ग्रहः** साध्यते।

तत्र किमर्थं कर्णवृत्तांशविशेषणम्? उच्चमध्यान्तरदोश्चाप-व्युदासार्थम्। किं तर्हि तत्र संस्कार्यम्? उच्चस्फुटान्तरदोश्चापम्। तत्कथं ज्ञायत इति? तदानयनं कर्णवृत्तांशशब्देन सूच्यते। कथम्? ग्रहमध्यमादुच्चं विशोध्य तद्भुजाया गृहीता अर्धज्या हि मण्डलयोरुभयोः साधारणी, कर्णमण्डलस्य प्रतिमण्डलस्य चोभयसम्पातगतत्वात्। सदैव ग्रहस्य उच्चनीचसूत्रस्य ग्रहसन्निकृष्टप्रदेशात् प्रवृत्तत्वाच्च, भुजायाः उच्चनीचसूत्रस्य च मध्यम-स्फुटकेन्द्रयोर्गोलसन्धिगतत्वाच्च। एकस्या एव भुजाज्याया मापकभेदादेव मण्डलयोर्द्वयोर्भेदः स्यात्। प्रतिमण्डलगतत्वेन कल्प्यमाना प्रतिमण्डल-खखषड्घनांश(२१६००)तुल्याभिर्मेया। कर्णमण्डलगतत्वेन कल्प्यमाना तत् स्वखषड्घनांशतुल्याभिः ज्योतिश्चक्रकलाभिरेव। तत्र केन्द्रस्य मकरादित्वे स्फुटकक्ष्यात्मकस्य कर्णस्य मण्डलस्य मध्यकक्ष्यामण्डलाद् बहिर्गतत्वात् स्फुटकक्ष्याकला मध्यकक्ष्याकलाभ्यो महत्यः स्युः। अतएव प्रतिमण्डल-कलाभ्यश्च महत्यः, कक्ष्याप्रतिमण्डलयोस्तुल्यत्वात्, कलानां च सर्वेष्वपि मण्डलेषु स्वपरिधिखखषड्घनांशतुल्यत्वात्। अत उक्तम्— **कर्णवृत्तांशदोश्चाप-युतोनोच्चम्** इति।

कथं कर्णवृत्तांशदोश्चापं ज्ञायते? त्रैराशिकेन। किं ब्रूमः प्रतिक्षणं विक्रियमाणानां कर्णकलानां, सदैव तुल्यपरिमाणानां इतरासां च सम्बन्धस्या-ऽनियतत्वात् कथं त्रैराशिकमुपपद्यते? नैष दोषः। उभयत्रापि ज्या-त्रिज्या-चाप-बाणादीनामैककालिकस्य मिथः सम्बन्धस्य नियमाद् अभीष्टकालवर्त्तै-रेकमण्डलभवैस्तात्कालिकानामितरमण्डलगतानामानयने त्रैराशिकमुपपद्यते। तत्र तन्मण्डलयोस्तात्कालिकसम्बन्ध एव ज्ञेयः। स च व्यासयोः परिध्योः ज्याबाणादीनां वा मण्डलगतानामेकदा एकप्रकार एव। ततो व्यासादिष्वन्य-

तमयोर्वृत्तद्वयगतस्तात्कालिके नियमे विदिते सति एकमण्डलगतेन विदितेन अन्यमण्डलगतमपि तत्स्थानीयं ज्ञेयम् । अतएव केन्द्रभुजाकोटिभ्यां महामण्डलगताभ्यां उच्चनीचवृत्तगते भुजाकोटिज्ये आनीयेते ।

देशभेदेष्वयमेव न्यायः स्यात् । अत एव क्षितिज्याचरादिकमपि तत्तद्देशाक्षावलम्बकादिभिः तत्तद्देशजमानीयते । अपक्रमक्षितिज्याकर्णाग्रादीनामेकस्मिन् देशे सदैव द्वयोर्द्वयोर्मिथःसम्बन्धस्यैकप्रकारत्वात् । अत्र तु मध्यस्फुटकक्ष्यागतानां द्वयीनां कलानां तत्तत्कालभवो मिथःसम्बन्धः क्वचिज्ज्ञेयः । स च स्फुटकक्ष्याव्यासार्धे दृश्यते । तत्रापि स्वकलामितं व्यासार्धं सदैव त्रिज्यासंख्यम् । तद्गता मध्यकक्ष्याकला एव प्रतिक्षणं भिन्नसंख्याः । तज्ज्ञानार्थं कर्णं आनीयते । तत्र केन्द्रबाहुज्या ग्रहभ्रमणवृत्तकलाप्रमिता, तद्गतचापगृहीतत्वात् । सैव भूग्रहान्तरकर्णस्य भुजा । केन्द्रकोटिज्या तु प्रतिमण्डलमध्यस्य भुजायाश्च विप्रकर्षः । कर्णसाधनत्वं तु उच्चनीचरेखागतभूभुजाविवरस्यैव । ततः प्रतिमण्डलभूविवरतुल्यस्योच्चनीचवृत्तव्यासार्धस्य मकरादौ केन्द्रकोटिज्यया संयोगः, कर्क्यादौ तु वियोगश्च कार्यः । सैव कोटिः कर्णसाधनभूता । सैव भुजोच्छ्रितिरुक्ता । अतस्तद्वर्गयोगमूलं स्फुटकक्ष्याव्यासार्धं मध्यकक्ष्याकलाप्रमितम् । तत् स्फुटकक्ष्याकलाप्रमितस्य त्रिज्यातुल्यासंख्यस्य सतस्तस्यैव व्युदासार्थं कर्णशब्देन विशेष्यते । भुजाकोटिक्षेत्रकल्पनयाऽवगतत्वात् तत्र कर्णशब्दो वर्तते ।

वृत्तः, व्यासार्धयोः सीमात्वेन कल्प्यमानस्य व्यासत्वं व्यस्यतेऽनेन वृत्तमिति । स्मर्यते च— 'विस्तारो विग्रहो व्यासः' इति **यादवप्रकाशाद्यैः** । तस्यार्धं व्यासार्धमित्येकस्यैव मापकभेदनिमित्तः संख्याभेदो वाचकभेदहेतुः । ताभ्यां मध्यमभुजज्यया च स्फुटभुजज्यानयनमेव । यदि तात्कालिककर्णतुल्याभिर्ग्रहभ्रमणवृत्तकलाभिः त्रिज्यातुल्यग्रहावधिकज्योतिश्चक्रकला लभ्यते, तदा तात्कालिकोच्चमध्यविवरज्यातुल्याभिः ग्रहभ्रमणवृत्तकलाभिः कियत्यो भगोलकला लभ्यन्ते इत्युच्चस्फुटग्रहान्तरदोर्ज्याकला लभ्यन्ते । ततस्तच्चापीकरणेन स्फुटकेन्द्रभुजाचापं लभ्यते । तच्चापयुक्तमुच्चं प्रथमपदे स्फुटग्रहः, तदूनं चतुर्थपदे [उच्चम्], द्वितीये तु तदूनं नीचम्, तृतीये तु तत्सहितं नीचं स्फुटग्रहः ।

नन्वेवम् एकस्मिन् केन्द्रपर्यये मध्यमस्फुटसाम्यस्य चतुरज्याऽऽवृत्तिः स्यात् । नैतदस्ति । केन्द्रभगणे एकस्मित् द्विरेव तत्साम्यं स्यात्, उच्चप्राप्तौ नीचप्राप्तौ च । ननु मेषादौ तुलादौ च [1]सकृत्कर्णस्य त्रिज्यासाम्यं स्यात् । तथा च मध्यमभुजज्यया स्फुटभुजज्यानयने गुणहारयोः संख्यासाम्यात्

व्याख्या—1. The expression **सकृत्** is repeated in the Ms.

मध्यमस्फुटभुजज्ययोरपि साम्यं स्यात्। चापसाम्ये मध्यमस्फुटयोरपि साम्यं स्यादिति चेत्— मैवम्। तदा मध्यमस्फुटभुजयोः पदभेदात् मध्यमस्फुटयोरपि भेदः स्यात्। कथं पदभेदः? तदानीं च ग्रहस्य प्रतिमण्डलनीचासन्नार्धगतत्वात् मध्यमकेन्द्रकक्ष्यादिगते तज्ज्याचापे स्याताम्। कर्णमण्डले पुनस्तस्यैव ग्रहस्य तदुच्चासन्नार्धगतत्वात् मकरादिगते ज्याचापे द्वे। अतो नीचमध्यान्तरं मध्यकेन्द्रभुजचापम्। उच्चस्फुटविवरम् प्रमाणफलयोः साम्यादिच्छाफलसाम्येऽपि फलत्वेन सिद्धस्य बाहोश्चापम्। इति महानेव तदानीं मध्यमस्फुटयोर्भेदः। मध्यमकेन्द्रकक्ष्यादौ यदान्त्यफलात् कोटेरल्पत्वं ततः कोटिः शोध्यते। तदैव च मध्यमस्फुटयोः पदभेदः स्यात्, नान्यदा। एवं प्रतिमण्डलस्फुटपरतया व्याख्यातम्।

अथ विधान्तरपरतया व्याख्यायते—तदा कक्ष्यामध्योच्चनीचस्पृक्सूत्रकक्ष्यामण्डलम् मध्ये तत्परिधिगतोच्चनीचकेन्द्रेऽपि स्पृष्टम्। तच्चोच्चनीचवृत्तोच्चप्रदेशाऽवधिकम्। यद्वा कक्ष्यामध्ये तत्परिधिस्थोच्चनीचवृत्तोच्चप्रदेशे नीचप्रदेशे च स्पृष्टम्। तस्य सूत्रस्य ग्रहस्य च यो विप्रकर्षः सा भुजा। सा च उच्चनीचवृत्तगता, तत्परिधिस्थत्वाद् ग्रहस्य। कक्ष्याप्रतिमण्डलोच्चनीचवृत्तकर्णमण्डलानां सन्निपात एव हि सदा ग्रहः। सदा तस्या उच्चनीचवृत्तगतबाहुज्यायाः उच्छ्रितिरेव कोटिः। कर्णः पूर्वोक्त एव। या पुनरुच्चनीचवृत्तगता कोटिः सा च तन्नाभिबाह्वन्तरा[ला]वगाहिव्यासार्धखण्डतुल्या, भुजाशरोनव्यासार्धस्य कोटिसाम्यात्। तस्याः कक्ष्याव्यासार्धस्य च संयोगो वियोगो वेह भुजोच्छ्रितिः। सैव कर्णसाधनभूता कोटिः। तत्रोच्चनीचवृत्तभुजाकोटिज्येन स्ववृ[त्त]कलाप्रमिते ग्राह्ये। के तर्हि? मध्यकक्ष्यकलाप्रमिते, यतस्तत्प्रमितः कर्णो जिज्ञास्यते? तत्रैवं त्रैराशिकम्—यदि षष्टिशतत्रयांशपरिमिते परिधौ केन्द्रभुजाकोटिज्ये उभे स्तः, तदा ग्रहभ्रमणवृत्तांशैः प्रमाय परिमिते स्वस्वोच्चनीचवृत्ते कियत्याविति। इति परिधिर्गुणकारः, षष्टयधिकशतसंख्यो भागहारः। तत्फले भुजाकोटिफलाख्ये। अत्र तु 'स्वांशैस्तान्यर्धपञ्चमैः' (सि० दर्पणम्, ८) इति वृत्तानामर्धपञ्चमापवर्तितत्वात् इच्छाप्रमाणयोरेकजातिकत्वाय प्रमाणव्य[ासा]र्धपञ्चमावर्तितम् अशीतिसंख्यं हारतया ग्राह्यम्। परितः परिधयोऽर्धपञ्चमा इति गुणिता वेच्छात्वेन ग्राह्याः इति कर्णविषयावयवयोजना, अत्र भुजाफलचापस्य मध्यमे संस्कार्यत्वात्।

कर्णवृत्तांशवोश्चापयुक्तोनोच्चस्फुटो ग्रहः ॥ २७ a ॥

इत्यत्र उच्चशब्देन उच्चनीचवृत्तस्य उच्चभागो विवक्ष्यते। तद्वृत्तमेव च मेषादेर्यतःकुतश्चिदवधेर्वा तत्तज्ज्योति[श्चक्र]वृत्तानां तत्तन्नाभ्याश्रान्ता-

वधिकस्य ग्राह्यत्वात् । ततोऽत्रोक्तोच्चनीचस्पृक्सूत्रभुक्तज्योतिश्चक्रगतराश्यादिके भुजाफलं संस्कार्यमित्यर्थः । तच्च ग्रहर्गणत्रैराशिकानीतमध्यमतुल्यम् । अत एवोक्तम्—

कक्ष्यामण्डललग्नस्य वृत्तमध्ये ग्रहो मध्यः ।

इति ।

नन्वत्रोक्तम्—भुजाफलं तच्चापं वा न कलाप्रमितम्, यतः ग्रहभ्रमणवृत्तत्वायैव यत्नः कृतः, न कर्णकलाप्रमितत्वाय । ततस्तदर्थं यत्नान्तरं कार्यम् । सत्यम् । तदपि कर्णवृत्तांशदोश्चापत्वोक्तेः सिद्धे मन्दवृत्तस्यैव स्वकर्णवच्च क्षयवृद्धी भवतः, न शीघ्रवृत्तस्य, तस्यापि दोर्ज्यावृद्धिक्षयवशात् क्षयवृद्धी स्तः इति तद्व्यवच्छेदार्थं एवकार इति ।

मन्दवृत्तस्य कर्णवत क्षयवृद्धिमत्त्वमिहोक्तम् । ततस्त्रैराशिकेनैव तात्कालिकमन्दवृत्तपरिमाणं ज्ञेयम् । तत्रैव त्रैराशिकम्—यदि तात्कालिककर्णे त्रिज्यातुल्यम्(? ल्ये) एतावान् परिधिः, तत इयति कर्णे कियानीति । तेन परिधिना प्राग्वदेव दोःकोटिफले कार्ये । यद्यन्त्यफलेन व्यासार्धेन प्रमाणेन च दोःकोटिफले आनीयेते, तदा अभीष्टान्त्यफलानयनेऽपि इदमेव त्रैराशिकम् । यद्वा पठितेनैव वृत्तेन दोःकोटिफले नीत्वा तयोः पृथक्पृथगेतदेव त्रैराशिकम् । ततस्त्रैराशिकसिद्धाभ्यां फलाभ्यां केवलया त्रिज्यया च इष्टकर्ण आनेयः, ततः कर्णे ज्ञात एव दोःकोटिफले ज्ञेये, तयोर्ज्ञातयोरेव कर्णश्च ज्ञेयः, इत्यन्योन्याश्रयतां परिहर्तुं असकृत्कर्मणा कर्णो विशेष्यते पूर्वैः । तत्र फलयोः पृथक्त्रैराशिकपक्षे फलयोरविशेषकर्णो गुणकारः, त्रिज्यैव हारः । अविशिष्टस्य भुजाफलस्य मध्यकक्ष्याकलाप्रमितत्वात् कर्णकलाप्रमितस्य चापस्यैव मध्यमे संस्कार्यत्वात् । ज्यारूपस्य भुजाफलस्य च उच्चनीचवृत्तकर्णमण्डलयोः साधारणत्वात् ।

कर्णमण्डलप्रमितत्वाय त्रैराशिके त्रिज्या गुणकारः, अविशेषकर्णो हारः । तत्पूर्वं त्रैराशिकस्य विपरीतकर्मैव । तत एकस्मिन् कर्मणि सर्वस्मिन् कृतेऽपि प्रथममानीतमविकृतवृत्तफलमेव लभ्यत इति, तदेव चापीकार्यमिति, मन्दस्फुटकर्मणि कर्णानयनादिकमुपेक्षणीयमेव । बिम्बमानादिज्ञानार्थमेव तन्मन्दकर्णानयनमुच्यते ।

तत्र अविशेषणस्य कर्मगौरवात्[1] सकृत्कर्मणा आनयनमुच्यते—

कर्णवृत्तांशबाह्वाद्यैमर्मान्दे कक्ष्यैव नीयते ॥ २७ b ॥

व्याख्या—1. The Ms. reads कर्णगौरवात्

इति। मन्दवृत्तस्य कर्णवत् क्षयवृद्धिमत्त्वात् तत्कर्णानयने य इतरेतराश्रयदोष उक्तः, स पूर्वोक्तप्रकार एव स्यात्। अन्यथापि मध्यमस्फुटकक्ष्ययोः तात्कालिको मिथः परिमाणसम्बन्धो ज्ञेयः। तद्व्यासार्धे उभे अपि एकेनैव मापकेन प्रमाय उभयोः संख्ययोः ज्ञातयोस्तयोः परिमाणतः सम्बन्धः एवं ज्ञायते—तद्भ्रमणतो यदा यावती संख्या तदा ततस्तावतिथांशैः अन्यतुल्यैरारब्धमल्पमिति अल्पस्य महता सम्बन्धः। अल्पस्य च यावती संख्या ततस्तावतिथांशैः अन्यतुल्यैरारब्धमन्यत् कर्णकलाप्रमितमिति। इत्यन्योन्यमङ्गाङ्गिभावः सम्बन्धः। तत्र उभयोर्मापकयोः तुल्यतया भाव्यमित्येव नियमः। तत्र ग्रहवृत्तकलाप्रमिते उभे पूर्वोक्ते। अत्रोक्ते तु कर्णकलाप्रमिते। तत्र स्फुटकक्ष्याव्यासार्धस्य कर्णकलाप्रमितस्य सर्वदाऽपि त्रिज्यातुल्यत्वात् तदिह ज्ञातम्। कर्णकलाप्रमिते भुजाकोटिफले च ज्ञाते। ततस्तैस्त्रिभिरज्ञातं कर्णकलाप्रमितं मध्यकक्ष्याव्यासार्धमिह नीयते। तदुक्तम्—

कर्णवृत्तांशबाह्वाद्यैमान्दे कक्ष्यैव नीयते ॥ २७ b ॥

इति।

स्ववृत्तकलाप्रमितस्य कर्णस्य सदैव त्रिज्यातुल्यत्वात् तेन मध्यकक्ष्याव्यासार्धानयने कर्णानयनविपरीतकर्म कार्यम्। तच्च **माधवेनोक्तम्**—

विस्तृतिदलदोःफलकृतिवियुतिपदं कोटिफलविहीनयुतम्।
केन्द्रे मृगकर्किगते स खलु विपर्ययकृतो भवेत् कर्णः।
तेन हृता त्रिज्याकृतिरयत्नविहिता विशेषकर्णः स्यात् ॥

इति। अत्र 'तेन हृता त्रिज्याकृतिः' इत्येतत् त्रैराशिकमेव। स्फुटकक्ष्याव्यासार्धस्य ग्रहभ्रमणवृत्तकलाप्रमितस्यैव संख्या गणितेन ज्ञेया। कर्णवृत्तकलाप्रमितस्य संख्या ज्ञातैव, सदैव त्रिज्यातुल्यः स्यात् (? तुल्यत्वात्) तस्याः। तया त्रैराशिकेन प्रतिक्षणं भिद्यमाना ग्रहवृत्तकलासंख्या कर्णाख्या ते (?) त्रैराशिकेनैव ज्ञेया। प्रमाणफलयोर्विदितयोर्वा इच्छया[1] त्रैराशिकं प्रवर्तते, लिङ्गलिङ्गित्वादुभयोः। तयोः सम्बन्धश्च मध्यकक्ष्याव्यासार्ध एव ज्ञेयः। तद्गतग्रहवृत्तकला ज्ञाता, त्रिज्यातुल्येति। तद्गतकर्णवृत्तकलासिद्ध्यर्थमिह कर्णविपरीतकर्म उक्तम्— **कर्णवृत्तांशबाह्वाद्यैः कक्ष्यैव इह नीयते।** इति। एवमुभयविधाना[म्] कलान[ाम्] तात्कालिके सम्बन्धे मध्यकक्ष्या-

व्याख्या—1. The Ms. reads इच्छाया

व्यासार्धे ज्ञाते। अन्यत्राप्येकविधकलानां संख्यया ज्ञातज्ञाततया (?) अन्याधीनानां कलानामपि तद्गता संख्या ज्ञेया । अत्र त्रैराशिवाचोयुक्तिश्चैवम्— इदानीं मध्यकक्ष्याव्यासार्धे ज्ञाते कर्णकलासंख्यया त्रिज्या [ज्ञा]ता । कर्णविपरीत-कर्मणाऽऽनीतया तद्गतैव ग्रहवृत्तकलासंख्या त्रिज्यातुल्यैव लभ्यते, तदा स्फुटकक्ष्याव्यासार्धगतया त्रिज्यातुल्यया स्वकलासंख्यया तद्गता ग्रहवृत्तकला-संख्या कियतीति । तत् किमिति अत्र न मीयते । 'मान्दे कक्ष्यैव नीयते' इति ह्युक्तम्, स्फुटकक्ष्याकलाप्रमिताभ्यां कक्ष्याद्वयव्यासार्धाभ्यामपि तत् त्रैराशिकस्य कर्तुं शक्यत्वात् । तत्र त्रिज्योक्तं कर्म विपरीतकर्मानीतेन कार्यम्, कर्णोक्तं कर्म त्रिज्यया च । तदपि—

सर्वत्र विष्कम्भदलं श्रुतौ वा व्यासार्धके स्याद् विपरीतकर्णः ।

इति अस्मद्गुरुणा उक्तम् । व्यासे दलीकृते, व्यासार्धस्थाने इति यावत् । तस्य सुखबोधत्वाच्च । '**एव**'-कारेण पूर्वैरुक्तकर्णानयनमेव निरस्यते । असकृत्कर्मणाप्यविशेषस्या सिद्धेश्च **नीयताम्** इति वा पाठः । मध्यकक्ष्याव्यासार्धेन स्फुटकक्ष्याव्यासार्धानयनम् । एवं मान्दकर्मणि इतरेतराश्रयदोषः, न पुनर्वैपरीत्ये। अत्र कर्णस्त्रिज्यातुल्यः कल्प्यः, फलाभ्यां सावर्ण्यार्थम् इत्येव विशेषः । पुनस्त्रैराशिके पुनर्नानाभूतः कर्ण आनीयतां वा, मा वा इत्यभिप्रायः ।

शीघ्रकर्णे तत्परिधेः कर्णानुसारि वृद्धिह्रासाभावात् नेतरेतराश्रयः । तत्र बाहुफलं च त्रिज्यागुणितं कर्णहृतं चापितं च संस्कार्यम् । तत्र अर्केन्द्वोर्मान्द-भुजाफलचापसंस्कृतमेव मध्यमं स्फुटं स्यात्, भ्रमत्प्रतिमण्डलमध्यमार्गभूतस्य मन्दपरिधेर्नाभ्या भगोलघनमध्यगतत्वात्, शीघ्रोच्चपरिधेरभावात् ।

'ज्ञातभोगग्रहं वृत्तम्' (सि० दर्पणम्, २२) इत्याद्युक्ता युक्तीः ग्रहस्फुटलम्बनादिषु तत्तदपेक्षिताः क्रमेण योजयिष्यामः । तत्र रवेर्विक्षेपाभावात् शीघ्रोच्चतत्परिध्योरभावाच्च मन्दोच्चतत्परिध्योः सद्भावाच्च तत्स्फुटयुक्तयः प्रथमं योज्यन्ते ।

तद्भ्रमणवृत्तं तत्र प्रतिमण्डलम् । ततस्तदत्र ज्ञातभोगग्रहं विवक्षितम्, यतः सदैव तन्नाभिगतदृष्टेस्तद्गतिः समैव । सैव मध्यगतिश्च, तस्य[ा] भगोलेन सहदेश-नाभिकत्वात्, भगोलगतराश्यादिस्थितिवशात्, कर्माधारभूत-कालविशेषाणाम् मासतिथिनक्षत्रादीनां च भगोलगत्यायत्तत्वात् । सैव ज्ञेया । तस्य[ा] मध्यगतिसाधनत्वादेव मध्यमानयनम् । तस्य[ाः] तिथ्याद्या-

[क्रान्तिः]

क्रान्तिकोटिद्युवृत्तेऽपि[1] स्वकला ह्यसुभिः समाः ।
अन्त्यद्युज्येष्टभक्रान्त्योः क्षेपकोटिघ्नयोर्युतिः ॥ २८ ॥

वियुतिर्वा ग्रहक्रान्तिस्त्रिज्याप्ता[2] कालदोर्गुणः ।
अन्त्यक्रान्तीष्टतत्कोट्योः स्वद्युज्याप्तापि पूर्ववत् ॥ २९ ॥

[व्यतीपातः—लाटवैधृतौ]

[3]अर्केन्द्वोरयनात् साम्ये लाटो मध्याच्च वैधृतः ।

[द्विस्पृग्वृत्तम्]

द्विस्पृग्वृत्तेऽर्कभासेन्दोरर्धं भात्यतिरोहितम् ॥ ३० ॥

नयनेनान्तरितमेव रवीन्द्वादिमध्यमानयनम् । तस्या भगोलघनमध्यगतदृष्टेः समन्ततो या गतिः सैव स्फुटगतिः । ग्रहभगोलघनमध्यप्रोतसूत्रगतिरेव हि तद्गतिः । तस्य[ाः] सर्वदा वेग[ा]साम्यम् । तद्वशादेव सौरमासादीनां भेदः । तत्सूत्रस्य मान्देय[?मान्द्ये] मासानां महत्त्वं शैघ्र्येऽल्पकालत्वं च । एवं नक्षत्रादे रवीन्दुसूत्रगतिवैषम्याद् वृद्धिह्रासौ । तस्माद् भगोलमध्यस्य तत्र ज्ञेयभोगत्वम्, तन्मध्यकर्णवृत्तगतेः ज्ञेयत्वात् । कर्णवृत्तमेव ज्ञेयभोगग्रहम् । तेन सदेशनाभिकं प्रतिमण्डलतुल्यं कक्ष्यावृत्तं कल्प्यते, मध्यस्फुटभुजान्तरप्रदेशप्रदर्शनार्थम् । तेन विनापि स्फुटयुक्तिः प्रदर्श्या । अतो लाघवायैव तत्कल्पनम् ।[1]

मूलम्— 1. E. F. omit पि

2. A. प्तं ; D. प्त ; F. and alternative reading in D, प्ता

3. F. भार्केन्द्वो (corrupt).

व्याख्या—1. The commentary in the Ms. breaks off here.

[ग्रहणादिः]

स्वदृग्गोलगतिक्षेपबिम्बैर्ज्ञेयं ग्रहादिकम् ।
तन्मध्यभुक्तिसाम्ये स्यादासत्तिर्भिन्नमार्गयोः ॥ ३१ ॥

[ग्रन्थसमाप्तिः]

विंशत्यानुष्टुभां स्पष्टं कृतं शास्त्रमिहाखिलम् ।
दशभिर्न्यायमार्गश्च संक्षेपादेत्र दर्शितः[1] ॥ ३२ ॥

॥ इति गार्ग्य-केरलसद्ग्राम-नीलकण्ठविरचितम्
सिद्धान्तदर्पणं समाप्तम् ॥

मूलम्— 1. B. has, after this, a verse indicating the name of the scribe and another on the subtraction of angles in arcs :

गार्ग्यकेरलसद्ग्राम-नीलकण्ठेन निर्मितम् ।
सिद्धान्तदर्पणं शास्त्रमलिखत् शङ्कराभिधः ॥

इष्टज्ययोश्च तत्कोटयोर्भेदवर्गैक्यतः पृथक् ।
द्वि(?त्रि)ज्याप्ताद्ध्यंशवर्गाढ्यान्मूलं चापान्तरं भवेत् ॥

श्रीकृष्णः प्रीयताम् ।

THE MIRROR OF THE LAWS (OF ASTRONOMY)

(Siddhānta-darpaṇa)

By

GĀRGYA-KERALA NILAKAṆṬHA SOMAYĀJI

Salutation

1. Having saluted the illustrious Dāmodara and also the divine Ravi (the author's teachers), (the knowledge of) the motion of heavenly bodies, which I have acquired through their grace, is expounded here.

I. UPADEŚA SECTION

Revolutions of the planets (Graha-paryaya)

2-5. Commencing from a sunrise at Laṅkā, the number of eastward revolutions of the Sun in a *kalpa* is four hundred and thirty-two multiplied by ten million, *i.e.*

	4,32,00,00,000
(that) of the Moon is	57,75,33,32,321
(that) of the Earth	15,82,23,78,39,500
(that) of Mars	2,29,68,62,137
(that) of Mercury	17,93,71,20,175
(that) of Jupiter	36,41,60,611
(that) of Venus	7,02,22,70,552
(and) of Saturn	14,65,71,016

These are the numbers of revolutions of the planets in a *kalpa* along their respective orbits (from west) to east.

(Of these) each of the planets other than the Earth is the lord of a day of the week.

Revolutions of the higher apses (Mandocca)

6-7 a. (The numbers of revolutions) of the higher apses (*mandocca*) of these (planets in a *kalpa*) are :

(Sun)	353
(Moon)	48,81,23,318

(Mars)	754
(Mercury)	494
(Jupiter)	601
(Venus)	272
(Saturn)	54

Revolutions of the ascending nodes (Śīghrocca)

7 b.-8 b. (The numbers of revolutions of the ascending nodes), which move backward (from the east) to the west, are, beginning with the Moon :

(Moon)	23,22,96,745
(Mars)	834
(Mercury)	902
(Jupiter)	825
(Venus)	766
(Saturn)	757

Maximum latitudes (Parama-vikṣepa)

8 b.-9 a. The (maximum) latitudes of the epicycles of the higher apses at their halves, depending on the distance of the planet from the nodes, are, in units of quarter degrees (*i.e.*, 15′) :

(Moon)	18 (×15=270′)
(Mars)	6 (×15= 90′)
(Mercury)	21 (×15=315′)
(Jupiter)	4 (×15= 60′)
(Venus)	11 (×15=165′)
(Saturn)	8 (×15=120′)

Epicycles of the equation of the apses (Manda-paridhi)

9 b.-c. (The magnitude of the circumferences[1] of the epicycles of the equation of the apses) in terms of 4½ parts of themselves (*i.e.*, in terms of 4½ degrees) are :

1. The magnitude of the circumference is given in proportion to that of the circumferences of the orbits of the respective planets which are taken to be 360°, the number of degrees in a circle.

(Sun)	3 (×4½=14°)
(Moon)	7 (×4½=31½°)
(Mars)	16 (×4½=72°)
(Mercury)	14 (×4½=63°)
(Jupiter)	8 (×4½=36°)
(Venus)	3 (×4½=14°)
(Saturn)	10 (×4½=45°)

Epicycles of the equation of conjunction (Śighra-paridhi)

9 d-10. (The circumferences of) the epicycles of the equation of conjunction, beginning with Mars, are, in the odd quadrants :

(Mars)	53 (×4½=238½°)
(Mercury)	31 (×4½=139½°)
(Jupiter)	16 (×4½= 72°)
(Venus)	59 (×4½=265½°)
(Saturn)	9 (×4½= 40½°)

These same (epicycles) reduced, respectively, by 2, 2, 1, 2, and 1 give the circumferences of the even quadrants :

(Mars)	51 (×4½=229½°)
(Mercury)	29 (×4½=130½°)
(Jupiter)	15 (×4½= 67½°)
(Venus)	57 (×4½=256½°)
(Saturn)	8 (×4½= 36°)

Measure of the Yuga-s

11. One thousandth of a *kalpa* is a *yuga*. Seventy-one (of these) *yuga-s* constitute (the period of) a Manu, (there being, thus, fourteen complete Manu periods in a *kalpa*). Between the periods of (each) Manu and at the beginning and end (of the *kalpa*) there are intercalary periods each equal to (the duration of) a *Kṛta* age.

12. The *Kṛta* and other ages (*viz.*, *Tretā*, *Dvāpara* and *Kali*) are, respectively, four-tenths, three-tenths, two-tenths and one-tenth of a *yuga*.

The present is the *Kali* age in the twenty-eighth *yuga* of the seventh Manu.

Segments of a revolution (Bhagaṇāṁśa)

13 a.b. The revolution of a planet can be divided into 12 (segments called signs, their) 30th (parts called degrees and the) 60th parts (of a degree called minutes).

Linear velocity of planets in yojana-s

13 c.d. The Moon's daily motion in minutes multiplied by ten will give the daily linear velocity of the planets (in *yojana-s*) (which is the same for all planets including the Sun and the Moon) (being 7906 *yojana-s*).

Diameters of the Earth, Moon, and Sun

14. The terrestrial sphere is 1050 *yojana-s* in diameter and it stands in the sky, in the centre of the celestial sphere, 'as the lowest point'.

The Moon is 315 *yojana-s* (in diameter) and the Sun 4410 *yojana-s*.

Position of the city of Avanti

15 a-b. The city of Avantī (Ujjain) lies (directly) north of Laṅkā (which is on the equator) by one fifteenth part of the circumference of the Earth.

The orbit of the stars (Nakṣatra-paridhi)

15 c-d. (The *Pravaha* wind) is driving the stars in a westerly direction (on an orbit equal to) sixty times that of the Sun.

The position of the ecliptic (Apakrama-vṛtta)

16. And thereby the two halves of the central circle of the celestial globe, (*i.e.*, the ecliptic), move away respectively towards the north and the south from the central (circle) of the *Vāyu-gola* (*viz.*, the *Viṣuvan-maṇḍala* or celestial equator) by 24 degrees.

Precession and procession of the equinoxes (Ayana-calana)

17. The conjunction (of the equinoxes) moves east and west by 27 degrees on each side. This increase and decrease (*i.e.*, moving east

and returning, then moving west and returning) occurs regularly, (each increase or decrease taking place) once in five divine years (*i.e.*, once in 1800 ordinary years).[1]

The position of the equinoxes at a specific date

18. Taking the time when one-eighth of the dawn[2] of the *Kali*-age had passed and increasing this number by its one-hundredth part (we find) a moment when the two solstices were roughly in the middles of Sagittarius (Dhanus) and of Gemini (Mithuna), respectively.[3]

Epicycles of the equations of the centre and conjunction (Manda-Śighra-vṛtta)

19 a-b. (The centres of) the circles, along which (the mean motion of) the planets takes place, move on (the circumference of) the epicycle of the equation of the centre (*manda* epicycles) with the velocity of the higher apses.

19 c-d. In the case of the Sun and the Moon it (*i.e.*, the *manda* epicycle) has its centre at the centre of the Earth-sphere.

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1. One divine year is equal to 360 ordinary years. Thus, to complete one oscillation, both ways, it would take $4 \times (5 \times 360) = 7200$ years.

2. The twelfth part of the total duration of a *yuga* in its beginning is its dawn (*sandhyā*) and the twelfth part at the end is the twilight (*sandhyāṁśa*).

3. The date works out to the Kali year 4545 (A.D. 1443). For:

No. of years in a *catur-yuga*		=	4320000 years
„ „ Kali-age	$\frac{1}{10} \times 4320000$	=	432000 „
Kali-age dawn	$\frac{1}{12} \times 432000$	=	36000 „
One-eighth part of above	$\frac{1}{8} \times 36000$	=	4400 „
One-hundredth part of the above	$\frac{1}{100} \times 4500$	=	45 „
Date specified		=	4545 Kali

The author says in his commentary that he has mentioned this to specify the year of his birth. *Cf.*, **स्वजन्मकालज्ञापनार्थं चैवमुक्तम्। तत्र अहर्गणश्च 'स्यजान्यक्षतां तर्कः'** (16,60,181) **इति।** (p. 17, above).

20 a-b. For the other (five planets) the centre (of the *manda* or 'slow' epicycle) moves on (the circumference of) the epicycle of the equation of conjunction, *i.e.*, the *śīghra* or 'fast' epicycle) with the mean velocity of the Sun.

20 c-d. The centre of their *śīghra* epicycle is the centre of the (celestial) globe itself and (the planes of) these (epicycles) are not oblique to (that of) the ecliptic ; (*i.e.*, they are in the same plane as the ecliptic).[1]

21. In the case of Mercury and Venus, their own orbits are stated to be the same as their *śīghra* epicycles, measuring them with respect to their *śīghra* epicycles (which are taken as 360 degrees each).

In the case of these, the increase and decrease of the *manda* epicycles alone are according to the hypotenuse (extended from the centre of the *manda* epicycle to its circumference where the planet is).

II. NYĀYA SECTION

Eccentric and Orbital Circles

(Pratimaṇḍala and Kakṣyāmaṇḍala)

22. In all cases, the circle on which the velocity of a planet is measured (from fundamentals) is termed the 'eccentric circle' (*prati-maṇḍala*). And, that circle on which the motion of the planet is to be (projected and) understood (*i.e.*, measured) is termed the 'orbital circle' (*kakṣyā-maṇḍala*).

23 a-b. When they are one outside the other, (the outer) one is called the upper (*ucca*) (circle) and (the inner) one lower (*nīca*) (circle).

23 c-d. Here, the two circles of radii equal to the difference between the centres of the orbital and eccentric circles are drawn at the extremities of the joining the two centres ; these two will then be the *ucca* (upper) and *nīca* (lower) circles.

24 a-b. The motions of the planet and higher apses are to be taken here in opposite directions.

1. The idea is that the 'fast' (*śīghra*) epicycles are concentric with the ecliptic and lie in its plane and that the celestial latitude (*vikṣepa*) of the planets is caused by the deflection of the 'slow' (*manda*) epicycles which move on the circumference of the 'fast' (*śīghra*) ones. The maximum deflection of each planet is given in verses 8c-9a above.

24c-25b. When the eccentric circle (*jñāta-bhogavṛtta*) is oblique in relation to the orbital circle (*jñeyabhoga-vṛtta*), their cosines (*koṭi*) are to be taken as their radii. And the difference or sum, (as the case of may be), of the sines of the two circles is to be taken as the latitude of the eccentric circle.

Definition of sine, etc.

25 c-d. The sum of the squares of the sine (*doḥ-bhuja*) and cosine (*koṭi-bhuja*) is a square with the hypotenuse as a side.

26. The sine is the (perpendicular) distance from the planet to the line joining the upper (*ucca*) and lower (*nīca*) points through the centre of the orbital circle. The cosine is the height of the perpendicular to the planet (from the centre of the orbital circle). And the hypotenuse is the distance from the centre of the orbital circle to the planet.

The Sphuṭa or geocentric position of a planet

27 a-b. The geocentric position of the planet is (obtained) by subtracting or adding the arc (*cāpa*) of the (above) sine measured as a part of a circle with the hypotenuse (as the radius) (*karṇavṛtta*), from or to (the position of) the apsis.

27 c-d. The *manda* epicycle is indeed to be derived from the angle, sine, etc. of the hypotenuse-circle (*karṇa-vṛtta*).

Declination (Krānti)

28 a-b. Even in diurnal circles substended at the ends of (different) declinations, the respective minutes are equal in number to the *prāṇa-s* (*i.e.* one-sixth of a *vināḍī*).

28c-29a. The (apparent) declination of a planet (*graha-krānti*) is obtained by multiplying (separately) the cosine of the maximum declination (*antya-dyujyā*) (24°) and the actual declination by the cosine of the latitude, and adding or substracting the results (as the case may be).

29 b-d. The same (apparent declination) can be derived also by adding to the result obtained by multiplying sine 90° by *kālajyā* to the results obtained by multiplying (separately) the maximum declination (24°) and the declination of the present planet by the cosine of the latitude.

Vyatīpāta-s : Lāṭa and Vaidhṛta

30 a-b. When the Sun and the Moon have equal declination in different *ayana-s*[1] (but remain in the same hemisphere, north or south), that is called *Lāṭa* ; and *Vaidhṛta* is when they have equal declination in the same *ayana* (but remain in different hemispheres).

The Lunar crescent

30 c-d. In the Lunar crescent (*dvi-spṛk-vṛtta*), that part of the Moon which is not hidden (from us) shines by the light of the Sun.

Eclipses

31 a-b. Eclipses should be calculated from their zenithal circles (*i.e.*, vertical circles, *dṛggola*), velocity, latitude, and (diameters of the) discs.

31 c-d. The planets are nearest to one another when the mean (angular) paths covered by them are the same.

Conclusion

31. The theory of the entire science (of astronomy) has thus been explained in twenty verses in the *anuṣṭubh* metre and in another ten, the (graphical) methods have also been (stated) briefly.

Thus ends

THE MIRROR OF THE LAWS (OF ASTRONOMY)

by Nīlakaṇṭha Somayāji

of the Garga-gotra, resident of the Kerala-sad-grāma

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1. *Ayana* connotes the movements of the Sun to the south and north of the equator.

APPENDIX I

सिद्धान्तदर्पणसिद्धपर्ययादयः

[मङ्गलाचरणम्]

[1]अभिवन्द्य गणेशानं दिनेशादीन् ग्रहानपि ।
सिद्धान्तदर्पणे सिद्धाः कथ्यन्ते पर्ययादयः ॥[2]

[ग्रहपर्ययाः]

अनूननूत्नानररागभानुः' 'कुरङ्गराडङ्गगुणस्स' सोमः ।
सर्गाय रक्तो जितधीरखिन्नः' 'प्रियार्थविच्छिन्नसुबोधसौम्यः'[3] ॥ १ ॥

'पूज्योऽस्तु नातः[4] कविताङ्गनानां' 'प्रमोशनासूरिरखिन्नसेनः' ।
'तोकं नृपस्सोमितमस्य नूनं' क्रमाविनादेर्भगणास्तु कल्पे ॥ २ ॥

PLANETARY REVOLUTIONS ETC.

Derived from the Mirror of the Laws (of Astronomy)

Salutation

Having bowed to the Lod of the Gaṇa-s and to the planets, beginning with the Sun, the revolutions and other (particularites of the planets) derived from the *Siddhānta-darpaṇa* are set forth here.

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1. Ms. used : No. 5867-I, ff. 169-72, of the Kerala Univ. Or. Res. Inst. and Mss. Library, Trivandrum. It begins with : हरिः श्रीगणपतये नमः । अविघ्नमस्तु ।

2. The introductory verse is not numbered in the ms.

3. This figure, *viz.*, 17,93,70,64,712 differs from that in the mss. A.B.G. of the text of the *Siddhantadarpaṇa*, which is 17,93,71,20,175.

4. The ms. reads नाथः, but नातः agrees with the correct number.

[मन्दोच्चपर्यया:]

चण्डांशो'र्गुणगो'-विधो'र्जयबलप्रस्यन्दजीवा'ऽसृजो
'वंशस्था', शशिनन्दनस्य 'विधवा', वाचस्पेत: 'पीनता' ।
काव्यस्य 'प्रसुखा', दिनेशजनुषो 'वामानना' च क्रमाद्
विस्पष्टं गदिता मृदूच्चभगणा: कल्पान्तकालोदिता: ॥ ३ ॥

[पातपर्यया: कल्पदिनानि च]

इन्दो. 'शम्भुसुतो धरारिगिरिनुद्', भौमस्य 'भल्लार्दनं'
चान्द्रे: 'प्राज्ञधनं', गुरो: 'शरविन:', काव्यस्य 'तातासनम्' ।
सौरे: 'सद्मसु' पातपर्ययगणा: कल्पे क्रमादीरिता
'नूत्नोन्मुग्धगजस्थयौधससुमोद्यानं' धरावासरा: ॥ ४ ॥

Revolutions of the planets (Graha-paryaya)

1-2. The (numbers of) revolutions (of the planets) in a *kalpa* are, beginning with the Sun :

Sun	432,00,00,000
Moon	57,75,33,32,321
Mars	229,68,62,137
Mercury	17,93,70,74,712
Jupiter	36,41,60,611
Venus	702,22,70,552
Saturn	14,65,71,016

Revolutions of the higher apses

3. 353 for the Sun, 48,81,23,318 for the Moon, 754 for Mars, 494 for Mercury, 601 for Jupiter, 272 for Venus and 54 for Saturn : thus have been stated, in order, the (numbers of) revolutions of the higher apses (of the planets) during the course of a *kalpa*.

Revolutions of the nodes and days in a Kalpa

4. Moon, 23,22,96,745 ; Mars, 834 ; Mercury, 902 ; Jupiter, 825 ; Venus, 766 ; and Saturn, 757 : these are the (numbers of) revolutions of the ascending nodes (of the planets) in a *kalpa*.

The number of (*savana* or mean solar) days in a *kalpa* is **15,77,91,78,39,500.**

[परमविक्षेपकलाः]

'असार'मिन्दो'निधनं' धराभुवः, 'शयालु' सौम्यस्य, 'नति'र्बृहस्पतेः ।
'मताय' दैतेयगुरो-'र्नरायनं' शनेः क्रमात् क्षेपकलाः परा इमाः ॥ ५ ॥

[मन्दवृत्तानि]

'गानं' 'सूनु'स्तपो' 'विद्या' 'दानं' 'लग्नं' 'नृपः' क्रमात् ।
मान्दा वृत्तकलाः सूर्याद् 'असुरै'रपवर्तिताः ॥ ६ ॥

[शीघ्रवृत्तानि]

'गुणो' 'योग'स्तपो' 'धर्मो' 'धनं' भौमात् क्रमादिमाः ।
ओजा वृत्तकलाः शैघ्रा 'असुरै'रपवर्तिताः ॥ ७ ॥

'कृष्णो' 'धीरो' 'मयः' 'सोमो' 'जनो' भौमात् क्रमादिमाः
युग्मे वृत्तकलाः शैघ्रा 'असुरै'रपवर्तिताः ॥ ८ ॥

Maximum latitudes

5. 270 for the Moon, 90 for Mars, 315 for Mercury, 60 for Jupiter, 165 for Venus and 120 for Saturn : these are the maximum latitudes in minutes (of the planets) in order.

Epicycles of the equation of the apses

6. 3, 7, 16, 14, 8, 3, 10 : these are, in order, beginning from the Sun, the circumferences of the epicycles of the equation of the apses (of the planets) in minutes divided by 270.

Epicycles of the equation of conjunction

7. 53, 31, 16, 59, 9 : these are, in order, beginning from Mars, the circumferences of the epicycles of the equation of conjunction in the odd quadrants, in minutes, divided by 270.

8. 51, 29, 15, 57, 8 : these are, in order, beginning from Mars, the circumferences of the epicycles of the equation of conjunction in the even quadrants, in minutes, divided by 270.

[कल्यादिध्रुवानि]

'जीवाढ्यभूनिखननेन' दिनाधिनाथः
'सारोद्धवः कुशधने नु' निशाधिनाथः ।
'नीलाब्जलासगजकायकृत्' उर्वराज-
'श्चेलावलीं तव निरूपय' चन्द्रसूनुः ॥ ९ ॥

'कृष्णोऽब्धिगः शिवमयो' ननु देवपूज्यः
'श्रीकृष्णनद्धशममन्य'सुरारिपूज्यः ।
'लोलम्बकान्तगिरिनुन्न' इनात्मजन्मा
'सोमोत्सुकोम्बुनिधिरत्न' हिमांशुतुङ्गः ॥ १० ॥

'धीनद्धचक्रनृपरोचन'मिन्दुपातः
कल्यादिजा ध्रुवगणाः खलु तत्पराद्याः ।
'ज्ञानोल्लसत्सूनमलार्तिनिरास' एते
कल्पादितो दिनगणाः कलितो ह्यधस्तात् ॥ ११ ॥

Position of the planets at the beginning of Kali

9.11.	*signs*	*degrees*	*minutes*	*seconds*	*tatparā*
Sun			20	41	48
Moon		4	51	49	27
Mars	11	18	37	38	30
Mercury	11	20	46	34	36
Jupiter		15	45	39	51
Venus	1	5	59	5	12
Saturn		2	36	13	33
Moon's higher apsis	3	29	3	17	57
Moon's ascending node	6	21	2	29	9

These are the positions (of the planets reckoned) from *tatparā* (1/60th of a second) onwards, at the commencement of the *Kali* age.

720,63,50,77,300 is the number of days from the beginning of the *kalpa* down to the commencement of the *Kali* age.

[४८०० कलौ मन्दोच्चध्रुवानि]

'शूली सपुत्रः', 'सुमतिर्नवीनो', 'विभुर्घनस्थः' 'कुशिको रणज्ञः' ।
'नम्यो नरेन्द्रः', 'क्षयजित्प्रसेनो' 'नूत्नाह्वा'ब्दे रवितो मृदूच्चाः ॥ १२ ॥

[४८०० कलौ पातस्थानानि]

'लीननयोयं' 'काननखिन्नः' 'षड्विधपत्रं' 'स्तेननृनेत्रम्' ।
'धिग्विधिनालं' पातगणाः स्यु'र्नूत्नह्वा'ब्दे भूमितनूजात् ॥ १३ ॥

Higher apses on Kali 4800 (A.D. 1698)

12. The position of the higher apses (of the planets), beginning with the Sun, at (the expiry of the *Kali*) year 4800, are :

	sign	*degree*	*minute*
Sun	2	17	35
Mars	4	6	57
Mercury	7	9	44
Jupiter	5	21	51
Venus	2	20	10
Saturn	7	28	16

Ascending nodes on Kali 4800 (A.D. 1698)

13. The position of the ascending nodes (of the planets), beginning with Mars, at the (expiry of the Kali) year 4800, are :

	sign	*degree*	*minute*
Mars	1	10	3
Mercury		20	1
Jupiter	2	19	46
Venus	2	0	6
Saturn	3	9	49

[१७,५५००० कलिदिनखण्डे ग्रहध्रुवाणि]

'अनूनशशिसेध्यो'नात् सूर्यवाराद्यहर्गणः ।
'हरो धर्मं शरोधंनं' 'पुरभित् पापसेवनः' ॥ १४ ॥

'पौरुषं न वरं रत्नं' रवीन्दूच्चध्रुवा इमे ।
'रघुवंनस्थो' भूपुत्रः 'सर्वविद्याज्ञ' इन्दुजः ॥ १५ ॥

'वेनो ज्ञानायनो' जीवो 'नाभिनृंपमुनि'भृंगुः ।
'दैवाधीनो नु' मार्तण्डिः 'परो हीनात्र' पन्नगः ॥ १६ ॥

सिद्धान्तदर्पणे सिद्धाः सूर्यादीनां ध्रुवा इह ।
रवीन्दूच्चा विलिप्ताद्या लिप्ताद्याश्च परे ग्रहाः[1] ॥ १७ ॥

[इति सिद्धान्तदर्पणसिद्धपर्ययादयः]

Planets on the 17,55,000th Kali day

14-17. From the (present) date of the *Kali* era reduced by 17,55,000, the week-day is to be reckoned from Sunday. The position of the planets as derived from *Siddhānta-darpaṇa* (at the expiry of that date) is given here, the Sun, Moon and the (Moon's) higher apsis from seconds onwards, and the other planets from minutes onwards :

	sign	*degree*	*minute*	*second*
Sun	9	22	59	28
Moon	8	21	14	21
Moon's apsis	2	24	6	21

The above are the positions of the Sun, Moon and (Moon's) higher apsis. (The following are those of the other planets) :

	sign	*degree*	*minute*
Mars	7	4	42
Mercury		14	47
Jupiter	1	0	4
Venus	5	10	40
Saturn		9	48
Moon's ascending node	2	8	21

[The above are the numbers of revolutions etc., derived from the MIRROR OF THE LAWS (OF ASTRONOMY)]

APPENDIX II

सिद्धान्तदर्पणस्थपर्ययभूदिनानि

'अज्ञानिनो ननु नरा लघुना' खरांशोः
'कुत्राङ्करागबलमर्थसमं' सुधाशोः ।
'जीयाद् बली रिपुजिदेव नु' तुङ्गकस्य
'स्थूलः परेषु जितधीरुरु' भूमिजस्य ॥ १ ॥

शंसी पुनस्त्रिपथगान्धुक' इन्द्रसूनोः (? न्धुसटेन्दुसूनोः)
'काव्यं तनोति कवितालम्' अमर्त्यपस्य ।
'श्रीमान्मुनिस्सुखिरुरुनं स' भार्गवस्य
'तापं नयेत्समितिवत् पुन'रर्कसूनोः ॥ २ ॥

'शोभासुताळिरुरुगौरि' विधुन्तुदस्य
'नूनं मिळद्गजसटोद्धसि साम कृत्स्नम्' ।
कल्पेऽत्र सूर्यमुखपर्ययभूदिनानि
व्यक्तं क्रमेण लिखितानि गुरोर्निदेशात् ॥ ३ ॥

सिद्धान्तदर्पणत्तिले भूदिनपर्यङ्ङल् ॥[1]

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1. A verse invoking the twelve *rāśi-s* or *bhāva-s* in a horoscope followed by the date of transcription are given after this in the manuscript :

लग्नकर्मायान्त्यबुद्धिरिष्फवित्तधनाश्रयाः ।
रक्षन्त्वर्कादयो नित्यं विश्रमे मीनसम्भवाः ॥
'सुतस्थश्शर्मसूज्योऽर्कः' कलिः ।
श्रीनारायणः प्रीयताम् ।

The above Kali date 17,55,767 works out to A.D. 1706.

REVOLUTIONS OF PLANETS AND NUMBER OF DAYS IN A KALPA

1-3.	Sun	432,00,00,000
	Moon	57,75,33,32,321
	Moon's higher apsis	48,81,23,318
	Mars	2.29,68,62,137
	Mercury	17,93,71,20,175
	Jupiter	36,41,60,611
	Venus	7,02,22,70,552
	Saturn	14,65,71,016
	Moon's ascending node	23,22,96,745
	Number of mean solar days in a *kalpa*	15,77,91,78,39,500

Thus have been set forth explicitly, as per the instructions received from our teacher, the (number of) revolutions (of the planets) beginning with the Sun, and the (number of) days in a *kalpa*.

Such are the days and revolutions in the

MIRROR OF THE LAWS (OF ASTRONOMY)

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ERRATA

Page	*Line*	*For*	*Reed*
8	1	पष्ठेद्	पष्ठेद् (? पठेद्)
10	4	श्लक्ष्णा	श्लक्ष्णा:
11	15	वर्षपस्तमा	वर्षपस्तस्मा
14	5	षड	षड्
16	7	गहीत्वा	गृहीत्वा
17	5	प्राण कलान्तर	प्राणकलान्तर
,,	17-18	चलांशास्त्वम्	चलांशास्स्वम्
20	24	कर्मींणि	कर्माणि
23	15	मागौ	मार्गौ
27	last line	तत्त etc.	तत्तन्नाभ्याक्रान्ता-
28	11	कर्णघत	कर्णवत्
30	8	त्रिज्योक्त	(? त्रिज्ययोक्त)
,,	9	कर्णोक्तं	कर्णोक्तं
,,	13	स्या सिद्धेश्च नीयतान्	स्यासिद्धेश्च नीयताम
,,	last line	तरय[।]	तस्य[।]